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THIRTY-THIRD ANNUAL REPORT

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

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JANUARY, 1896.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
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Commonwealth of Massachusetts.

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, Jan. 1, 1896.

To His Excellency FREDERIC T. GREENHALGE.

SIR: — I have the honor to transmit, herewith, to your Excellency and the Honorable Council, the thirty-third annual report of the trustees of the Massachusetts Agricultural College.

I am, very respectfully,

Your obedient servant,

HENRY H. GOODELL,
President.

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ANNUAL REPORT OF THE TRUSTEES

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

His Excellency the Governor and the Honorable Council.

Feb. 20, 1895, there passed away from our midst the oldest member of our Board, one who had served continuously for twenty-six years. Daniel Needham was appointed in 1869, and from that time to the day of his death was a faithful, conscientious worker. He never spared himself when duty was to be performed, even, in his last illness, rising from his bed in a vain endeavor to keep an appointment in Boston and discuss measures of importance to the college. As chairman of the finance committee, his course was always marked by a wise conservatism. As member of the committee on experiment department, he helped outline and shape the policy which has since been pursued. At the semi-annual meeting of the trustees, held in Amherst, June 18, 1895, the following resolution, expressive of the estimation in which he was held, was adopted: —

Resolved, That in the death of Hon. Daniel Needham, for more than a quarter of a century a trustee of our Agricultural College, the Commonwealth has lost a most valued and respected citizen, who had often been the recipient of honors both from the government and the people at large. Our college has lost the oldest of our trustees, who was exceeded by no one in his earnestness in the welfare of the institution, and by his ready activity to promote, by word and deed, by wise counsels and faithful attendance, the best interests of the college.

Individually we shall miss his genial presence and his hearty greetings at our meetings, and deeply we shall feel the loss of a positive and reliable friendship.

Attendance.

It has been frequently asserted that, in times of financial trouble, the attendance at our colleges and universities shows no diminution, but is, if anything, increased. Statistics would seem to indicate that in the panics of 1873, 1884, 1890 and 1893, the numbers at Yale, Harvard, Amherst and Williams showed no falling off. However this may be the case with the so-called classical institutions, it is not so with the agricultural and mechanical colleges. These respond at once to the pressure of hard times. Their ranks are recruited, for the most part, from the classes who have no reserve capital upon which to fall back, and who are consequently compelled to recall their sons and enter them at once in the army of bread winners. The past two years have been no exception to this rule. The college has felt in a marked degree the stringency of the times. Another cause operating to produce this decrease in numbers has been the increased requirements for entrance, which went into effect last year. Out of a total of sixty-two young men applying for admission, six failed to present themselves for trial, assigning as a reason their inability to pass the examinations, sixteen were rejected, and, of the forty-one admitted, only fourteen were passed without conditions. As in previous years, the greatest deficiency was noted in the common English branches. The ignorance displayed of the very rudiments of grammar and arithmetic would almost lead to the conclusion that the grammar school had been suppressed throughout the State.

Course of Study.

Important changes have been made in the curriculum. Latin as a requirement for entrance and as a required study has been dropped. Four new electives are offered in the senior year: one of engineering and one of mathematics, under Prof. Leonard Metcalf; * and two in the department of languages, one of Latin and one of advanced English. Both of the latter will be under the supervision of Prof.

* See mathematical department, under head of equipment.

George F. Mills. In nearly every class a few members are found desirous of prosecuting the study of Latin. To give these few the opportunity of so doing, without compelling the majority to spend their time over what they do not want, this elective is offered.

It has been deemed impracticable to longer carry on the two-years course, and it has been discontinued. In its place a number of short winter courses have been substituted, all optional, all free (except minor laboratory fees) to citizens of this State, and all without limitation of entrance examination. As they are planned to offer the greatest good to the greatest number in a limited period of time, not exceeding eleven weeks, the instruction will necessarily be more or less elementary in its character, but as thoroughly practical as it can be made. Neither degree nor diploma will be conferred.

The dairy course is expected to cover such practical points as soil and crops; dairy breeds and cattle breeding; stable construction and sanitation; common diseases of stock; foods and feeding; dairy book-keeping; pasteurization of milk; composition of milk; milk testing; butter making, etc.

In addition to the above, two courses each are offered in agriculture, botany, chemistry and zoölogy, and three in horticulture, the last named naturally subdividing into floriculture, fruit culture and market gardening. Practical points taken up include the use and application of manures; growth of grains and fruits; budding, layering and grafting; plant diseases and their remedies; insecticides and fungicides; anatomy and physiology of the domestic animals, and their condition and habits. In short, the whole aim in all these courses is to present, in condensed form, within the brief limit allowed, such practical instruction in agriculture and the allied sciences as will be most helpful to the farmer. Of necessity, this arrangement of studies, as here presented, must be more or less tentative. Experience alone can determine what should be increased and what eliminated. The double courses provided permit of concentrated attention upon a single subject in one year, or of continuous study in successive years, provided the instruction commends itself as being profitable.

It has been our effort each year to give our students a course of lectures on some given subject. This year the topic was "Politics," and the subject was practically presented by Mr. Raymond L. Bridgman of Boston, for many years legislative reporter, under the following heads: —

1. Our State government; or, the people as an organism.
2. Government by the people; or, how the organism is guided.
3. Development by legislation; or, how the organism grows.
4. Progress by the ballot; or, how the weak parts of the organism are strengthened.
5. Neglect of the government; or, a constant danger to the organism.
6. Separateness and frequency of elections; or, the intensity of the organic life.

The Faculty.

The resignations of Prof. Clarence D. Warner, who for ten years held the chair of mathematics and physics, and of A. Courtenay Washburne, the assistant professor of mathematics, necessitated an entire change in that department and a partial reorganization of the course of study. The position made vacant by the withdrawal of Professor Warner was filled by the election of Leonard Metcalf, B.S., a graduate of the Institute of Technology, Boston, in 1892. An accurate, thorough scholar, and an enthusiast in his profession, he brings to his chair a practical knowledge of his subject, derived from a three years' experience in the engineering office of Wheeler & Parks, Boston. Professor Washburne's place was made good by the election of Philip B. Hasbrouck, B.S., a graduate of Rutgers College, New Jersey, in 1893. Dr. James B. Paige, professor of veterinary science, having received a year's leave of absence, for the purpose of familiarizing himself with the latest methods of bacteriological investigation practised abroad, left in July. Instruction in his department has been given by Dr. Eugene H. Lehnert, a graduate of this college in 1893 and of the veterinary school of Magill University, Canada, in 1895.

Expenditure of State Appropriations.

The several amounts appropriated by the State have been expended judiciously and for the purposes intended. Two hundred dollars, found inadequate for the enlargement of the botanical laboratory, has been covered back into the treasury of the State. An entomological laboratory, thirty-two by thirty-six feet, containing stands and appliances for sixteen students, was erected and immediately utilized. This much-needed addition to our equipment allows us to offer first-class instruction in entomology, and facilities not to be found elsewhere.

The erection of a gun room, twenty-eight by sixty feet, with shooting gallery for practice during the winter months, enables us to comply with the conditions imposed by the war department on issuing the new breech-loading steel rifles, and with the spirit of the law requiring military instruction at the college. The expenditure for stock is detailed elsewhere in the report of the agricultural department.

On the 11th of September a storm burst upon the college, surpassing in fury any heretofore recorded. "With a normal though slightly falling barometer, temperature of 84°, wind from the south-south-east, and a clear sky, suddenly, about three o'clock in the afternoon, there came from the north-east a hurricane accompanied with blinding sheets of rain, bright flashes of lightning, and terrific gusts of wind, reinforced by a steady gale and mass of hail. For nearly twenty minutes the storm fairly raged, but had spent itself at the end of half an hour, when the wind ceased and the sun shone brightly. The gale had left a record of a velocity of ninety-three miles per hour, a sudden fall of 14° in temperature, and an inch and a third of rain, fully an inch and a quarter of which must have fallen in twenty minutes. Several hailstones were found by one observer, measuring two inches in length, and one at least one and one-quarter inches in diameter."* Trees were split and broken by the storm, standing corn was blown down, and the fruit and

* From the September meteorological bulletin of the Hatch Experiment Station.

vegetables so badly damaged as to be almost worthless. Several tons of grapes were destroyed, and pears, peaches, quinces, apples and other fruits were either blown from the trees or so bruised as to be unsalable; over seven hundred panes of glass in the greenhouses were cracked or broken; the copper flashings on the roof of the chapel were rolled up like paper, and considerable slate stripped off and scattered in fragments on the parade ground. The loss footed up to about twelve hundred dollars. This extra expense, coming so near the close of the year, when all moneys had been appropriated, caused not only great inconvenience, but has compelled the college to exceed its income. It would seem proper in this emergency to appeal to the State for aid. Other subjects demand careful consideration.

First. — The horticultural department has outgrown its limits, and demands more ground for orchards and nurseries. It would seem the part of wisdom to purchase the so-called Clark property, containing about twenty acres. It is now in the market, and its position — lying adjacent to the college nurseries — makes its acquisition peculiarly desirable.

Second. — The work of the experiment station has increased to such an extent that the laboratory is no longer adequate. The rooms are overcrowded, and space cannot be found either for the workers or the appliances used. There is no shelf room available. Retorts, glass ware and delicate instruments must be left on the tables, when not in use, to their own detriment and the great inconvenience of the chemists. An easy remedy can be provided by lengthening the wings, each twenty to thirty feet, and connecting the two by a covered arch. This will secure the needed space and furnish room for storage and special work.

Third. — The mortar on the spire of the chapel-library building has so badly weathered that sooner or later pointing will be required. Whenever this is undertaken, it will involve considerable outlay for the erection of the wooden scaffolding necessary for the workmen.

Fourth. — It seems necessary to provide a proper building for a light and power station for the electric plant. Its present location is entirely unsuitable, presenting conditions

best fitted for spoiling the machinery, instead of keeping it in good working order. In the report of the engineer in charge, he says: "The location of the coal bin and boiler, in relation to the milk and other rooms of the dairy school, is bad, for there is no possible way in which the dust and soot from the boiler can be prevented from covering the floors of the room. Again, the location of the engine under the milk room and the dynamo under the barn floor renders them liable to injury from the leakage of water every time the floors are washed. Last, the location of the smoke stack, with the top almost on a level with the ventilators of the barn, and only thirty or forty feet from either, is a constant menace to the buildings, on account of the sparks that might be carried into them by a chance draft."

To recapitulate briefly, it is asked that there be appropriated: —

For loss occasioned by hail storm, ...	$1,200
For purchase of the Clark property and placing it in workable condition, ...	5,500
For extending the laboratories of the experiment department, .	7,000
For repair of chapel spire, a sum sufficient.	
For providing a suitable building for a light and power station, a sum sufficient.	

FARM REPORT.

The operations on the farm during the past year have been attended with a fair measure of success. The culture of our crops, however, constitutes an exception in some particulars. We have had some poor crops, and prices are unprecedentedly low. The most important single cause of small yields was inferior seed. The mid-summer months, moreover, were too dry for the best results in the field. The most important effect was a comparatively small yield of rowen.

The number of acres in the several crops of the year was as follows: grass, 74; potatoes, 16½; onions, 3; beets, carrots and Swedes, 1 each; corn for the silo, 23; field corn, 16½; millet, 3, and oats and pease, 2, — a total of 141 acres. In this statement six and one-fourth acres are counted twice, as a field of five acres of corn for the silo followed grass cut for hay, and another field of one and one-fourth acres was ploughed and sown to millet after the hay was removed. Then the land which produced the oats

and pease and a part of the millet land bore also a crop of barley for fodder. The total money value of the products — estimating hay at $14 per ton, corn at 45 cents per bushel, potatoes at 25 cents per bushel, small potatoes at 12½ cents per bushel, onions at 25 cents per bushel, beets at $6 per ton, carrots at $10 per ton, Swedes at $6 per ton, silage at $4 per ton and green fodder at $4 per ton — amounts to $6,148.81, — an average of $45.80 per acre. This is $2.35 per acre less than last year; but, had potatoes and onions commanded the prices of last year even, — prices which we then looked upon as very low, — the acre value of our products would have stood at $52.09, which is about $4 higher than last year. On the other hand, hay is $2 per ton higher this year than last. The net advance, therefore, on the basis of equal prices, is only about $1 per acre. Of course this point is not brought out to show a profit, because we cannot change price facts; but simply that we may have a fair basis on which to judge the results of our farming operations. On this basis we see that the productive capacity of the farm has been somewhat increased.

The acreage and products of the year were as below: —

Hay. — Total, 74 acres; first crop, weighed as put in, 166 tons and 394 pounds; rowen, weighed as put in, 38 tons and 665 pounds; average, 2.69 tons per acre.

Potatoes. — Sixteen and one-half acres; merchantable tubers, 2,577 bushels; small tubers, 350 bushels. About one-fourth of this area was the site and immediate surroundings of our old farm buildings; this could not be graded and prepared until rather too late for the best results, and the soil was not in condition to produce large crops. On about two-thirds of the remainder we used seed of our own raising, — Beauty of Hebron, — and for some reason that we cannot understand it did not come up well. Those plants which came were many of them weak, and as a consequence the yield was small. Beauty of Hebron seed from Maine, managed and planted in the same manner as the other, gave a fine crop. There was some rot in parts of the field which were moist. As a consequence of the various unfavorable conditions named, our average product is the lowest for several years; viz., 156.2 bushels merchantable and 21 bushels small tubers per acre.

Field Corn. — South slope, 8 acres; shelled corn, 640 bushels; stover, 25 tons. North flat, 5 acres; shelled corn, 225 bushels; stover cut green into silo, 35,670 pounds; fodder, 2 tons. South flat, 3 acres; shelled corn, 225 bushels; stover, 7½ tons.

Corn for the Silo. — Seventeen acres; 416,425 pounds, weighed into silo; 15 tons fodder, fed green; 40 bushels shelled corn and ½ ton stover.

Corn for the Silo, following Hay. — Six acres; 109,840 pounds, weighed into the silo.

Onions. — Three acres; 837 bushels sound onions.

Beets. — One acre; 15 tons.

Carrots. — One acre; 18 tons.

Swedes. — One acre; 7 tons. This crop was very much injured by the great hail storm.

The manures and fertilizers applied to the several crops are shown in the following table: —

Applications per Acre.

	Old Mowings.	New Mowings, Second Year.	Field Corn, on Sod.	Field Corn, on Stubble.	Corn for the Silo.	Potatoes.	Onions.	Mangolds (Beets).	Swedes.	Carrots.	Millet.	Oats and Pease.
Manure (cords),	-	-	4	-	5	-	-	-	-	-	-	-
Nitrate of soda (pounds),	200	150	100	125	100	125	150	200	125	125	200	150
Dried blood (pounds),	200	-	-	200	100	200	200	200	150	150	100	100
Dry ground fish (pounds),	100	100	100	200	100	100	300	400	200	200	100	100
Cotton-seed meal (pounds),	200	100	100	200	-	200	150	300	300	300	200	200
Plain superphosphate (pounds).	-	-	100	200	100	400	200	300	200	150	150	100
South Carolina rock phosphate (pounds).	100	100	100	100	100	100	150	150	150	150	100	100
Sulphate of potash (pounds),	-	-	-	-	-	300	300	-	-	-	-	-
Muriate of potash (pounds),	150	150	125	200	125	-	-	600	400	400	250	350

As we were for several months without cattle in the summer and autumn of 1894, the amount of manure available for use upon the farm was much smaller than it has been for many years; we have accordingly used fertilizers to a much greater extent than in any previous year. In making the applications indicated in the above table, it was my aim to supply phosphoric acid and potash in larger amounts than the crops raised would carry away, thus accumulating a reserve store of these elements for the use of crops in future years. In supplying nitrogen, I aimed to furnish more nearly the amounts the crops carried away would contain; but I did not lose sight of the fact that the decaying sod and stubble could in some cases furnish considerable of the required nitrogen, or of the further fact that the plants of the clover family would be able to take part of this nitrogen from the air. In short, I figured closely on this element, as experience shows that it is very liable to waste, since soils cannot hold its soluble forms. In supplying nitrogen, I aimed

to furnish it in forms of differing degrees of availability. For example, for onions, nitrate of soda for immediate use, then dried blood, dry ground fish and cotton-seed meal for later use.

In the case of phosphoric acid I followed a somewhat similar rule; superphosphate for immediate use, cotton-seed meal, fish and South Carolina rock phosphates for later use and succeeding seasons. The less soluble phosphates are cheaper than the others. The potash is all furnished in the form of soluble salts, but the soil can hold potash applied in these forms, and those selected are among the cheapest available potash fertilizers. Most of these fertilizers were mixed just before use, spread broadcast after ploughing, and harrowed in. For hoed crops, as a rule, some of the more soluble materials were put in the drill.

Late Corn for the Silo. — It seems desirable to say a few words concerning this crop. The field of six acres on the campus had been in grass about twelve years, and Kentucky blue grass was the prevailing species. This produces one fair crop, but very little rowen. It seemed desirable to plough and re-seed with more productive species of grass. The grass was cut about the middle of June, and yielded two tons of hay to the acre. Ploughing was begun June 19, and the field was planted June 24–25. It received a light dressing of barn-yard manure and 5,600 pounds of wood ashes, both spread after ploughing, and harrowed in. Three hundred pounds per acre of Bradley's special corn fertilizer were drilled in with the seed, — one-half bushel of Longfellow corn per acre. The crop reached the roasting-ear stage; almost every stalk bore a good ear, and some of the earliest were beginning to glaze. It was badly torn and injured by the hail and wind, and was touched by one light frost before it was cut. The yield was nearly 55 tons, as weighed into the silo. This fodder contained about $33\frac{1}{3}$ per cent. of dry matter, having the following composition: —

Composition of Dry Matter of Late-planted Corn for the Silo.

	Protein (Per Cent.).	Crude Fat (Per Cent.).	Cellulose (Per Cent.).	Nitrogen-free Extract (Per Cent.).
Longfellow corn fodder, . .	9.15	1.65	28.96	54.92

This is very nearly as good as the average of mature (glazed) flint corn fodder.

The yield, rather over nine tons per acre, is of course not large,

but as a second crop it is a profitable one. It would undoubtedly have been considerably larger but for the severe storm alluded to. This field was sown to timothy, red top and clover early in August, and now promises good crops of hay next season.

Field Corn and Silage from the Same Field. — From one field of corn of five acres we picked the ears, throwing into light windrows on the ground. We then cut the stalks and immediately hauled to the barn and cut into the silo. More labor is involved in this system than in cutting ears with stalks into the silo. It is, however, sometimes desirable for certain classes of stock to have silage not containing grain. Under these circumstances this method appears to be a good one. The corn when the ears were picked was just glazed. The ears cured very well upon the ground, but the grain is undoubtedly somewhat less plump and heavy than under the ordinary system of stooking. They do not dry as well as in the stook, and when hauled should be put into rather narrow and thoroughly ventilated cribs. The stalks as cut into the silo had the composition shown below. For comparison I give the average as stated by Jenkins and Winton.

Stalks, Longfellow corn, at glazing period: dry matter, 27.4 per cent.
Average flint corn fodder, glazed: dry matter, 22.9 per cent.

Composition of Dry Matter.

	Protein (Per Cent.).	Crude Fat (Per Cent.).	Cellulose (Per Cent.).	Nitrogen-free Extract (Per Cent.).
Longfellow corn stalks,	9.33	1.29	29.53	57.64
Average flint corn fodder (glazed),	9.20	3.70	18.90	63.20

It will be seen that these stalks compare very favorably with average corn fodder in composition. This would appear to be, then, a good method of utilizing a corn crop, as there can be no doubt that such stalks will make good silage, and in this form they will all be eaten, while if dried in the ordinary way there is almost inevitably considerable waste.

Live Stock.

Horses. — There has been no sickness among our horses during the year, and we now have the following animals: Percherons: 1 stallion, 1 mare, 2 stallion colts; 1 three-fourths Percheron mare, 3 three-fourths Percheron colts; French coach: 1 stallion colt and 1 mare colt; 2 mares and 2 geldings; total, 14.

Cattle. — Since my last report another car load of heifers has been purchased in South Dakota. These are nearly all grade Shorthorns, like the cows and heifers purchased there last year. Some of the less desirable for dairy purposes of both importations will be fattened. We propose to retain sixty head as a foundation upon which to build up a dairy herd by crosses with bulls of the dairy breeds. The animals put into our barn last year have shown every indication of perfect health throughout the year. They are rugged and hearty, and among those which have calved are found a fair share of good milkers. The average yield is far less than with our old herd, but this is only what was anticipated. We looked for constitution as a basis for a profitable dairy herd and believe we have got it.

For crossing with the Dakota cattle and for educational purposes we have put into our barns pure-bred animals, beginning with one male and one female of each, of the following breeds: Shorthorn, Guernsey, Jersey, Ayrshire, Holstein-Friesian and Aberdeen-Angus. These animals were tuberculin tested before purchase, and have all appeared perfectly healthy since we obtained them. They have all been re-tested this fall, and, showing no indications of tuberculosis, have (with the exception of the Jerseys) been put into the new barn. The Jerseys were received later than the others, and will be kept in quarantine somewhat longer.

Of neat cattle we now own as follows: Shorthorns: 1 bull, 1 cow, 1 heifer; Guernseys: 2 bulls, 1 cow; Jerseys, 1 bull, 1 heifer; Ayrshires: 1 bull, 1 heifer; Holstein-Friesian: 1 bull, 1 cow, 1 heifer; Aberdeen-Angus: 1 bull, 1 cow, 1 heifer; Dakota animals: 26 cows, 52 heifers; grade Hereford: 1 heifer; total, 95.

Sheep. — Our flock has suffered from two attacks by dogs during the year, the total number of animals lost being nine. It is true that we receive payment for animals killed; but as these are often among the choicest of the flock (true in this case), and those left are seriously injured by the fright, the damage is serious and the discouragement great. The dog law should be modified so that sheep husbandry may not become entirely a lost art among us.

Our flock now includes the following animals, all pure-bred Southdowns: 1 ram, 26 breeding ewes, 3 ram lambs, 8 ewe lambs; total, 38.

Swine. — Our swine have but recently been purchased. We have excellent animals (one male and one female) of each of the following breeds: Berkshire, Tamworth, Cheshire, Poland-China and Chester-White; total, 10.

From what has been written, it will be seen that our facilities for instruction in matters pertaining to live stock are much more

extensive than ever before. I desire that it shall be recognized that our stock has been selected with reference largely to educational value, and not with a view to profit.

Farm Receipts.

The total receipts of the year for products sold and for labor performed for other departments by farm teams and men amount to a little more than $8,000. The leading items contributing to this total are the following: hay, $889.27; potatoes, $1,378.73; dairy products, $750.27; beef, $303.16; sheep, lambs and wool, $413.35; corn, $581.71; wood and lumber, $2,264; and work, $517.49.

Permanent Improvements.

The work of improvement has been prosecuted as opportunity presented itself. The most important items for the year are the following: —

The breaking up and clearing of the two-acre stump lot just south of our barns has been completed; a very good crop of corn for the silo was raised thereon, and the lot is now seeded to grass.

One hundred and twenty-five rods of new farm road, including one substantial stone culvert, have been built. The cellars of the old barn and farm-house have been filled, and the surroundings graded and fitted for cultivation. The fence surrounding the old paddock has been taken up and reset for the new inclosure. Substantially constructed yards connected with our piggery have been built.

The grounds about the farm-house in its new location have been graded and seeded, and planted with ornamental trees and shrubs. The site of the old horse shed and pine grove and the old drives about them have been cleared, graded and seeded.

The most important and extensive work has been that done in clearing and burning, harrowing and seeding the wood lot south of the Plainfield road. The brush on about twenty-seven acres has been cut, the lot burned over, the remnants of branches, etc., piled and burned, the ground between the stumps harrowed, and all sown with a mixture of grass and clover seeds. These made a good start, and the lot, for which we now have purchased the necessary fencing materials, will furnish a great deal of pasturage another season.

It has been found necessary to repaint the steel roofs of our new buildings. Upon the recommendation of the contractors doing the work, the roofs were first painted with a graphite paint made by the Dixon Crucible Company. This was an ex-

pensive paint, and it was expected that it would prove considerably more durable than the ordinary iron oxide paints. This expectation was disappointed. The roofs began to rust within a very few months after they were painted, and soon got into very bad condition. They have now been rubbed with a steel brush where badly rusted, and all covered with two coats of boiled linseed oil and iron oxide paint. This has necessitated an expenditure of $267, of which sum the company that originally did the work furnished $40. The roofs now appear to be in fine condition, and it is hoped they will need no further attention for several years.

Conclusion.

The plant food account, which is kept with our several fields, shows that the soil in almost all, as a result of the operations of the past year, has been considerably enriched in phosphates and potash; while, since clover finds an important place in all our mowings, it is believed that we have added to the store of nitrogen which will become available for future crops. It is confidently anticipated, therefore, that, with the large amount of manure we are now making, the crops of another season will be larger than ever before, — and that with a smaller expenditure for fertilizers.

Our fields will more and more largely be used in such a manner as to serve educational purposes and to throw light upon some of the many problems in the great field of agriculture. I believe, with Professor Sanborn, in *extensive* intensive farming, in the larger use of machinery and labor-saving methods; and, as our land is gradually still further cleared, drained, graded and laid out, we hope to illustrate such methods in a worthy manner.

Some of the Western correspondents of the agricultural papers claim to be able to produce potatoes at from five to twelve cents per bushel. We are fortunately so protected by freight rates that we are not obliged to meet these men on equal terms; but, on the other hand, we must incur an expenditure for fertilizers from which these Western farmers are at present exempt. The actual plant food (nitrogen, phosphate and potash) contained in one hundred bushels of potatoes can at the present time be purchased for less than five dollars. It is true that we must apply more to get the one hundred bushels; but it is possible to so manage as to recover most of the surplus in future crops, and it should be possible also to draw some of the required nitrogen from the air by means of the clover "nitrogen traps." The actual fertilizer cost of potatoes can, I believe, be kept as low as five cents per

bushel, and, since freight from most of the great centres of potato production is more than this figure, it should be possible for our farmers to successfully compete in the production of this crop; but they can do this only by adopting the labor-saving methods of their competitors. Such methods are possible only with large and well-cleared fields, and these methods we can illustrate here, — by the use of the sulky or gang plough, the potato planter, Breed's weeder, the potato digger, Leggett's Paris Green gun, etc. The cost of labor and seed this year with our poor crop was less than nineteen cents per bushel. Had our seed all been good and the entire field well suited for the crop, the labor cost would undoubtedly have been only about twelve cents per bushel. Last year, on our best field, 4.6 acres, the labor cost of the crop stored in the cellar was but little more than thirteen cents per bushel.

The potato is but one of the many crops with which such illustrations can be and are given here; and it is hoped that along this line the farm is entering upon an enlarged field of usefulness to the farming public as well as to our students.

I desire, finally, to testify to continued faithful and interested work on the part of superintendent, foreman and laborers, as well as to cordial support and encouragement from superiors. To all I tender my sincere thanks.

WILLIAM P. BROOKS,
Professor of Agriculture and Director of the Farm.

AMHERST, Dec. 26, 1895.

GIFTS.

From Sir JOHN B. LAWES of Rothamsted, Eng., "Rothamsted experiments over fifty years;" "Feeding of animals;" "Rotation of crops."

Prof. H. B. ADAMS of Baltimore, Md., picture of Lord Amherst; "Maryland's influence in founding a national commonwealth."

THE MILITARY INSTRUCTORS stationed at the college, picture of Napoleon.

E. B. BRAGG (M. A. C., '75) of Cleveland, O., collection of birds' eggs.

JOSEPH E. POND, Esq., of North Attleborough, six volumes "Bee Journals."

J. S. SANBORN of Poland, Me., seven engravings of French coach horses.

From J. A. HARWOOD of Littleton, two portraits belted Dutch cattle; one set "Herd Books," belted Dutch cattle.

J. M. THORBURN & Co. of New York, seeds of new fodder plant.

J. M. SEARS of Boston, Jersey bull and heifer.

GENESEE SALT COMPANY of Genesee, N. Y., samples dairy and table salt.

GREGORY & SON of Marblehead, several varieties millet seed.

JOSEPH BRECK & SONS of Boston, one variety potato.

H. D. FEARING of Amherst, one variety potato.

E. HICKOK of Rose, N. Y., one variety potato.

J. WILEY & SONS of New York, "Agricultural calendar for 1895."

MASSACHUSETTS SOCIETY FOR PROMOTING AGRICULTURE, "Infectiousness of milk."

Mrs. W. S. CLARK of Newton, Balch's "Mines, miners and mining interests of the United States."

AMERICAN HUMANE EDUCATION SOCIETY, "Vivisection."

COLLEGE READING ROOM ASSOCIATION, four volumes magazines.

Miss ELEANOR A. ORMEROD of Spring Grove, Eng., "Report of observations of injurious insects, 1894."

CARL FREIGAU of Dayton, O., "Ohio Poland-China Record."

W. H. CALDWELL (M. A. C., '87) of Peterboro, N. H., sixth volume "Guernsey Herd Register."

Hon. GEORGE F. HOAR of Washington, D. C., one hundred and thirty-three volumes government publications.

Hon. HENRY C. LODGE of Washington, D. C., twenty-five volumes government publications.

GINN & Co. of Boston, "Book of Elizabethan lyrics."

BOARD of AGRICULTURE, England, "Report of experiments with potatoes and onions."

J. B. LINDSEY (M. A. C., '83) of Amherst, "Creamery practice;" "Darmstadt Agricultural Experiment Station."

I. C. GREENE (M. A. C., '94) of Fitchburg, "American crow."

Hon. JOHN E. RUSSELL of Leicester, thirty-one copies "The Monroe Doctrine."

INDIAN RIGHTS ASSOCIATION, annual reports of executive committee, 2–12.

AMERICAN-ANGUS BREEDING ASSOCIATION, six volumes "Herd Book."

BUREAU of AMERICAN REPUBLICS, nineteen volumes.

From A. H. WINCHELL of Minneapolis, Minn., two volumes "Geological survey of Minnesota."

HOLSTEIN-FRIESIAN ASSOCIATION, thirteenth volume "Herd Book."

Mrs. H. J. CLARK of Amherst, Clark's "Lucernariæ."

SANDER'S PUBLISHING COMPANY of Chicago, Ill., Plumb's "Indian Corn."

In addition to the customary reports from the treasurer and the military department, I have the honor, in conformity to the law requiring the college in its annual report to publish such information as may be useful to the community, to append the annual report of the experiment department of the college, and an illustrated monograph by Prof. Charles H. Fernald on the "Crambidæ," a class of insects peculiarly destructive.

Respectfully submitted, by order of the trustees,

HENRY H. GOODELL,
President.

JAN. 1, 1896.

TREASURER'S REPORT.

Report of George F. Mills, *Treasurer pro tem. of Massachusetts Agricultural College, from Jan. 1, 1895, to Jan. 1, 1896.*

	Received.	Paid.
Cash on hand Jan. 1, 1895,	$853 13	–
Morrill fund,	1,000 00	–
Term bill,	4,569 21	$956 32
Horticultural department,	5,454 78	7,491 68
Farm,	8,324 77	12,293 39
Expense,	1,223 63	8,365 17
Salary,	701 05	13,772 27
Endowment fund,	11,082 16	–
State scholarship fund,	15,000 00	–
Chemical laboratory,	1,098 26	776 49
Botanical laboratory,	93 50	98 95
Entomological laboratory,	48 00	68 06
Zoölogical laboratory,	96 00	75 57
Labor fund,	5,379 71	5,117 72
Gassett scholarship fund,	85 88	147 50
Whiting Street fund,	62 30	60 85
Grinnell prize fund,	42 50	60 00
Mary Robinson fund,	35 84	60 00
Burnham emergency fund,	200 00	80 00
Hills fund,	356 16	459 93
Extra instruction,	–	612 50
Advertising,	–	635 30
Library fund,	565 02	565 02
Investment, N. Y. C. & H. R. R.R. stock,	4 25	–
Insurance,	89 35	649 12
Insurance, barn,	48 70	898 55
Insurance, vehicles, tools, etc.,	37 25	616 26
Electric plant,	441 24	2,976 22
Cash on hand Jan. 1, 1896,	–	55 82
	$56,892 69	$56,892 69

This is to certify that I have this day examined the accounts of George F. Mills, treasurer *pro tem.* of the Massachusetts Agricultural College, from Jan. 1, 1895, to Jan. 1, 1896, and find the same correct, properly kept, and all disbursements vouched for, the balance in the treasury being fifty-five and eighty-two one-hundredths dollars ($55.82), which sum is shown to be in the hands of the treasurer.

CHARLES A. GLEASON, *Auditor.*

Amherst, Dec. 27, 1895.

CASH BALANCE, AS SHOWN BY THE TREASURER'S STATEMENT, BELONGS TO THE FOLLOWING ACCOUNTS:

Burnham emergency fund,	$55 82

BILLS RECEIVABLE JAN. 1, 1896.

Term bill,	$1,080 74
Horticultural department,	228 55
Farm,	578 65
Expense,	149 26
Electric plant,	184 51
Chemical laboratory,	341 82
Botanical laboratory,	10 00
Zoölogical laboratory,	56 00
Entomological laboratory,	8 00
	$2,637 53

BILLS PAYABLE JAN. 1, 1896.

Horticultural department,	$359 26
Farm,	3,505 70
Electric plant,	275 53
Expense,	279 06
Chemical laboratory,	74 93
Labor fund,	404 44
Insurance, barn,	2,509 16
Insurance, vehicles, tools, etc.,	101 70
Gassett scholarship fund,	26 02
Whiting Street fund,	67 51
Grinnell prize fund,	20 00
Mary Robinson fund,	13 08
Burnham emergency fund,	303 48
Hills fund,	43 73
Morrill fund,	1,000 00
	$8,983 60

INVENTORY — REAL ESTATE.

Land.

	Cost.	
College farm,	$37,000 00	
Pelham quarry,	500 00	
Bangs place (with house, shed and barn),	2,525 00	
		$40,025 00

Buildings.

	Cost.	
Drill hall,	$6,500 00	
Powder house,	75 00	
Gun shed,	1,600 00	
Stone chapel,	31,000 00	
Amounts carried forward,	$39,175 00	$40,025 00

Amounts brought forward,	$39,175 00	$40,025 00
South dormitory,	37,000 00	
North dormitory,	36,000 00	
Chemical laboratory,	10,360 00	
Entomological laboratory,	3,000 00	
Farm-house,	4,000 00	
Horse barn,	5,000 00	
Farm barn and dairy school,	33,000 00	
Graves house and barn,	8,000 00	
Boarding-house,	8,000 00	
Botanic museum,	5,180 00	
Botanic barn,	1,500 00	
Botanic barn addition,	1,000 00	
Tool house,	2,000 00	
Durfee plant house and fixtures,	12,000 00	
Small plant house, with vegetable cellar and cold grapery,	4,700 00	
President's house,	11,500 00	
Dwelling-house, purchased with farm,	7,500 00	
		228,915 00
		$268,940 00

PERSONAL PROPERTY.

Electric plant,	$8,700 00
New York Central & Hudson River Railroad stock,	100 00
Botanical department,	3,610 00
Horticultural department,	7,006 11
Farm,	15,903 70
Chemical laboratory,	2,149 00
Botanical laboratory,	2,056 53
Natural history collection,	4,758 79
Veterinary department,	1,443 39
Agricultural department,	2,675 00
Physics department,	5,471 28
Library,	17,080 00
Fire apparatus,	450 00
Furniture,	640 00
Books in treasurer's office,	297 82
	$72,341 62

SUMMARY.

Assets.

Total value of real estate, per inventory,	$268,940 00
Total value of personal property, per inventory,	72,341 62
Bills receivable, per inventory,	2,637 53
	$343,919 15

Liabilities.

Bills payable, per inventory,	$8,983 60
	$334,935 55

Maintenance Funds.

Technical educational fund, United States grant,	$219,000 00
Technical educational fund, State grant, . .	141,575 35
	$360,575 35

Two-thirds of the income from these funds is paid to the treasurer of the college and one-third to the Institute of Technology. Amount received by the college treasurer from Jan. 1, 1895, to Jan. 1, 1896, ...	$11,082 16
Hills fund, the gift of Messrs. L. M. and H. F. Hills of Amherst, now amounts to $8,542. By conditions of the gift the income is to be used for the maintenance of a botanic garden. Income from Jan. 1, 1895, to Jan. 1, 1896, . .	356 16
Annual State appropriation, $10,000. This sum was appropriated for four years by the Legislature of 1889, and continued for another four years by the Legislature of 1892, for the endowment of additional chairs of instruction and for general expense. Five thousand dollars of this sum was set apart as a labor fund, to be used in payment of labor performed by needy and worthy students. Amount received from annual State appropriation for college expense from Jan. 1, 1895, to Jan. 1, 1896, ...	5,000 00
Amount received as labor fund, ...	5,000 00

Scholarship Funds.

State scholarship fund, $10,000. This sum was appropriated by the Legislature in 1886, and is paid to the college treasurer in quarterly payments. Amount received from Jan. 1, 1895, to Jan. 1, 1896, ...	10,000 00
Whiting Street fund, $1,000. This fund is a bequest without conditions. To it was added, by vote of the trustees in January, 1887, the interest accrued on the bequest, $260. Amount of the fund, Jan. 1, 1896, $1,260. Income from Jan. 1, 1895, to Jan. 1, 1896, ...	62 30
Gassett scholarship fund, $1,000. This sum was given by Hon. Henry Gassett as a scholarship. Income from Jan. 1, 1895, to Jan. 1, 1896, ...	85 88
Mary Robinson fund, $858. This fund was given without conditions. The income from it has been appropriated for scholarships to worthy and needy students. Income from Jan. 1, 1895, to Jan. 1, 1896, ...	35 84
Amount carried forward, ...	$31,622 34

Amount brought forward, ...	$31,622 34

PRIZE FUNDS.

Grinnell prize fund, $1,000. This fund is the gift of ex-Gov. William Claflin, and is called Grinnell fund, in honor of his friend. The income from it is appropriated for two prizes, to be given to the two members of the graduating class who pass the best examination in agriculture. Income from Jan. 1, 1895, to Jan. 1, 1896, ...	42 50

MISCELLANEOUS FUNDS.

Library fund, for the benefit of the library. Amount of fund, Dec. 31, 1895, $9,420.47.	
Burnham emergency fund, $5,000. This fund is a bequest of Mr. T. O. H. P. Burnham, late of Boston, and was made without conditions. The trustees have voted that this fund be kept intact, and that the income from it be used by the trustees for such purposes as they believe to be for the best interests of the college. Income from Jan. 1, 1895, to Jan. 1, 1896, ...	200 00
Income from Jan. 1, 1895, to Jan. 1, 1896, ...	$31,864 84

To this sum must be added amount of tuition and room rent, and receipts from sales from farm and from botanic gardens. These amounts can be learned from treasurer's statement, tuition, laboratory taxes and room rent being included in term bill account.

REPORT OF THE PRESIDENT OF THE MASSACHUSETTS AGRICULTURAL COLLEGE TO THE SECRETARY OF AGRICULTURE AND THE SECRETARY OF THE INTERIOR, AS REQUIRED BY ACT OF CONGRESS OF AUG. 30, 1890, IN AID OF COLLEGES OF AGRICULTURE AND THE MECHANIC ARTS.

I. *Condition and Progress of the Institution, Year ended June 30, 1895.*

The hard times seriously affected the prosperity of the college during the year ending June 30, 1895, although the total attendance was but slightly less than that of the preceding year. An assistant in the chair of botany has increased the teaching force to nineteen. The most important changes have been the separation of the chairs of horticulture and botany, previously united under one head, and the consolidation of the State Experiment Station with that established by the federal government, under the name of the Hatch Experiment Station of the Massachusetts Agricultural College, the two together forming the experiment department of the college. This has been with a view to securing economy of work and uniformity of result, and to simplifying questions of administration. Under this new departure, the president of the college becomes director of the station.

An instructive course of lectures on "Civil Polity" was given to the college during the year by Mr. R. L. Bridgman of Boston, and a series of lectures by various scientific authorities was planned and carried out under the auspices of the Natural History Society.

Under appropriation from the State, a building to be used as a laboratory has been commenced, for the benefit of those receiving instruction in economic entomology; a gun shed with practice gallery has been erected, and important additions have been made to the library.

II. *Receipts for and during the Year ended June 30, 1895.*

1. Balance on hand July 1, 1894,	$167 01
2. State aid: (*a*) Income from endowment,	3,637 07
(*b*) Appropriations for building or other special purposes,	15,000 00
(*c*) Appropriations for current expenses,	10,000 00
3. Federal aid: (*a*) Income from land grant, act of July 2, 1862,	7,300 00
(*b*) For experiment stations, act of March 2, 1887,	15,000 00
(*c*) Additional endowment, act of Aug. 30, 1890,	13,333 33
4. Fees and all other sources,	560 00
Total receipts,	$64,997 41

III. Expenditures for and during the Year ended June 30, 1895.

1.	College of Agriculture and Mechanic Arts,	$49,997 41
2.	Experiment Station,	15,000 00
	Total expenditures,	$64,997 41

IV. Property and Equipment, Year ended June 30, 1895.

Agricultural department: —	
Value of buildings,	$264,340 00
Value of other equipment,	$67,188 67
Total number of acres,	384
Acres under cultivation,	250
Acres used for experiments,	60
Value of farm lands,	$41,000 00
Amount of all endowment funds,	$360,575 35

V. Faculty during the Year ended June 30, 1895.

		Male.	Female.
1.	College of Agriculture and Mechanic Arts, collegiate and special classes,	19	–
2.	Number of staff of Experiment Station,	18	1
	Total, counting none twice,	29	1

VI. Students during the Year ended June 30, 1895.

1.	College of Agriculture and Mechanic Arts, collegiate and special classes,	192
2.	Graduate courses,	14
	Total, counting none twice,	206

VII. Library, Year ended June 30, 1895.

1.	Number of bound volumes June 30, 1894,	*15,440
2.	Bound volumes added during year ended June 30, 1895,	*943
	Total bound volumes,	16,383

* Pamphlets, none.

MILITARY DEPARTMENT.

AMHERST, MASS., Dec. 31, 1895.

To President H. H. GOODELL,
Massachusetts Agricultural College.

SIR: — I have the honor to submit the following report of the military department of the college for the year ending Dec. 31, 1895.

During the past year the military equipment has been increased by two 3.2-inch breech-loading steel guns; these are the same as those used in the United States Army, and represent the principles governing the construction of all field artillery used at the present day. Facilities for military instruction have been further increased, by the construction of a balcony across the south end of the drill hall, and a gun shed, twenty-eight by sixty feet, west of the drill hall, with which it is connected by an enclosed passageway. This gun shed is now used as a place of storage for the field guns. On its west side a shooting gallery has been built, where during the winter months the members of the lower classes will receive instruction in the principles of target practice, such instruction being of great importance before they are sent to the target range during the summer term. The gun shed is of a size sufficiently large to permit of its being used as the armory; the only changes necessary would be the ceiling of the shed, to make it warmer, and the transferring of the gun racks now in the armory. The present armory room could then be used as a lavatory, shower baths especially being much needed in connection with the gymnasium, which is in the drill hall. The outside of the drill hall requires painting, in places the paint having commenced to peel off; otherwise the entire building is in excellent repair.

The instruction in this department has been, as in previous years, both practical and theoretical.

Practical. — The battalion is at present organized with three companies and a band; the instruction has been in the "school of

the soldier," "school of the company," "school of the battalion," and "extended order;" during the winter term the junior class received instruction in "sabre drill," and during the fall term the sophomore and second-year classes in "bayonet exercise" and artillery. All members of the battalion are required to attend target practice, details being sent each drill day, when the weather permits, under a cadet lieutenant, to the target range for that purpose. The total number of shots fired during the last college year was 2,645, 123 students participating in this practice; the arm used was the Springfield cadet rifle. Certain members of the senior class have received instruction in signalling, both with the flag and heliograph.

Theoretical. — This instruction has consisted of recitations in the "Infantry Drill Regulations," by the senior, freshman and first-year classes, and of lectures given to the senior class on military law, explosives, fortifications, art and science of war, army administration and other kindred subjects. I consider this instruction of great importance, especially to members of the senior class who are of sufficient age to appreciate it, and who are thus enabled to obtain some slight knowledge of a subject seldom understood by civilians, and which may become of great importance to them in future years.

It has been my aim, during my tour of duty here, to impress on the students the necessity of discipline, and I have been much pleased at the manner in which my efforts have been rewarded. All students of the college, except post-graduates, are required to attend drill, except those excused by the surgeon on account of physical disability; there are three drills each week, of one hour. The total number of students receiving military instruction at the present time is 101.

A gold medal was given last winter by Mr. I. C. Greene of Fitchburg as a prize to the student best drilled in the "Manual of Arms." This medal was won by Cadet C. A. Norton of Lynn, a member of the present junior class; the judge was Capt. J. S. Pettit, United States Army, at present military instructor at Yale University.

The following three members of the last graduating class were reported to the Adjutant-General of the Army and to the Adjutant-General of the State of Massachusetts as having shown the greatest proficiency in the art and science of war: —

Henry A. Ballou, ...	*West Fitchburg, Mass.*
Edile H. Clark, ...	*Spencer, Mass.*
Robert S. Jones, ...	*Dover, Mass.*

The following is a list of the United States government property now on hand: —

Ordnance.

2 3.2-inch breech-loading steel guns.
2 8-inch mortars, with implements.
2 gun carriages.
2 gun caissons, with spare wheels.
2 mortar beds.
147 Springfield cadet rifles.
147 infantry accoutrements, sets.
51 headless shell extractors.
100 blank cartridges for field guns.
4,000 metallic ball cartridges.
3,000 metallic blank cartridges.
350 friction primers.
2 mortar platforms.
6,000 pasters.
100 targets, paper.
35,000 cartridge primers.
25,000 round balls.
1 hand reloading tools, set.
100 small-arms powder, pounds.
2 implements and equipments for 3.2-inch breech-loading steel guns, sets.

Signal.

2 heliographs, complete.
6 2-foot white flags.
6 2-foot red flags.
6 canvas cases and straps.
12 joints of staff.

The battalion organization is as follows: —

Commandant.

Lieut. W. M. Dickinson, ... U. S. Army.

Commissioned Staff.

Cadet First Lieutenant and Adjutant, . . F. E. DeLuce.
Cadet First Lieutenant and Quartermaster, . N. Shultis.
Cadet First Lieutenant and Fire Marshal, . . F. H. Read.
Cadet First Lieutenant and Assistant Instructor of Musketry, ... R. P. Nichols.
Cadet First Lieutenant and Assistant Instructor in Signalling, ... J. L. Marshall.

Non-Commissioned Staff.

Cadet Sergeant-Major, ... G. D. Leavens.
Cadet Quartermaster-Sergeant, ... J. L. Bartlett.

Color Guard.

Cadet Color Sergeant, ...	J. A. Emrich.
Cadet Color Corporal, ...	C. A. Norton.
Cadet Color Corporal, ...	C. A. Peters.

Band.

Cadet First Lieutenant and Band Leader, Commanding Band, ...	W. B. Harper.
Cadet First Sergeant and Drum Major, . .	C. I. Goessmann.
Cadet Band Corporal, ...	F. W. Barclay.

Companies.

Cadet Capt. P. A. Leamy, ...	assigned to Company A.
Cadet Capt. I. C. Poole, ...	assigned to Company C.
Cadet Capt. H. C. Burrington, . .	assigned to Company B.
Cadet First Lieut. A. S. Kinney, . .	assigned to Company A.
Cadet First Lieut. H. T. Edwards, . .	assigned to Company B.
Cadet First Lieut. F. B. Shaw, . . .	assigned to Company C.
Cadet Second Lieut. E. W. Poole, . .	assigned to Company A.
Cadet Second Lieut. W. L. Pentecost, .	assigned to Company B.
Cadet Second Lieut. F. L. Clapp, . .	assigned to Company C.
Cadet First Sergeant C. A. King, . .	assigned to Company A.
Cadet First Sergeant J. M. Barry, . .	assigned to Company B.
Cadet First Sergeant H. J. Armstrong, .	assigned to Company C.
Cadet Sergeant P. H. Smith, Jr., . .	assigned to Company B.
Cadet Sergeant H. F. Allen, . . .	assigned to Company B.
Cadet Sergeant G. A. Drew, . . .	assigned to Company A.
Cadet Sergeant J. W. Allen, . . .	assigned to Company A.
Cadet Sergeant L. F. Clark, . . .	assigned to Company C.
Cadet Sergeant M. E. Cook, . . .	assigned to Company C.
Cadet Corporal C. F. Palmer, . . .	assigned to Company B.
Cadet Corporal L. L. Cheney, . . .	assigned to Company A.
Cadet Corporal A. Montgomery, Jr., .	assigned to Company C.
Cadet Corporal R. D. Warden, . . .	assigned to Company A.
Cadet Corporal J. P. Nickerson, . .	assigned to Company A.
Cadet Corporal G. H. Wright, . . .	assigned to Company C.

Arrangements have recently been made for a competitive individual drill, preceded by a review, to take place in Mechanics Hall, Boston, on the evening of May 15, 1896, the participants being students from the Massachusetts Institute of Technology, Harvard University, Brown University and this college. I desire to take about twenty-seven of the cadets from our battalion to Boston on that day.

Respectfully submitted,

W. M. DICKINSON,
Lieutenant United States Army.

CALENDAR FOR 1896–97.

1896.

January 2, Thursday, winter term begins, at 8 A.M.

March 19, Thursday, winter term closes, at 10.15 A.M.

April 2, Thursday, spring term begins, at 8 A.M.

June 13, Saturday, Grinnell prize examination of the senior class in agriculture.

June 14, Sunday, { Baccalaureate sermon. Address before the College Young Men's Christian Association.

June 15, Monday, { Burnham prize speaking. Meeting of the alumni. Flint prize oratorical contest.

June 16, Tuesday, { Class-day exercises. Military exercises. Reception by the president and trustees.

June 17, Wednesday, Commencement exercises.

June 18–19, Thursday and Friday, examinations for admission, at 9 A.M., Botanic Museum, Amherst; at Jacob Sleeper Hall, Boston University, 12 Somerset Street, Boston; and at Sedgwick Institute, Great Barrington. Two full days are required for examination, and candidates must come prepared to stay that length of time.

September 1–2, Tuesday and Wednesday, examinations for admission, at 9 A.M., Botanic Museum.

September 3, Thursday, fall term begins, at 8 A.M.

December 23, Wednesday, fall term closes, at 10.15 A.M.

1897.

January 6, Wednesday, winter term begins, at 8 A.M.

March 25, Thursday, winter term closes, at 10.15 A.M.

THE CORPORATION.

	Term expires.
HENRY S. HYDE of Springfield,	1897
MERRITT I. WHEELER of Great Barrington,	1897
JAMES S. GRINNELL of Greenfield,	1898
JOSEPH A. HARWOOD of Littleton,	1898
WILLIAM H. BOWKER of Boston,	1899
J. D. W. FRENCH of Boston,	1899
J. HOWE DEMOND of Northampton,	1900
ELMER D. HOWE of Marlborough,	1900
FRANCIS H. APPLETON of Lynnfield,	1901
WILLIAM WHEELER of Concord,	1901
ELIJAH W. WOOD of West Newton,	1902
CHARLES A. GLEASON of New Braintree,	1902
JAMES DRAPER of Worcester,	1903
SAMUEL C. DAMON of Lancaster,	1903

Members Ex Officio.

His Excellency Governor FREDERIC T. GREENHALGE, *President of the Corporation.*

HENRY H. GOODELL, *President of the College.*

FRANK A. HILL, *Secretary of the Board of Education.*

WILLIAM R. SESSIONS, *Secretary of the Board of Agriculture.*

JAMES S. GRINNELL of Greenfield, *Vice-President of the Corporation.*

WILLIAM R. SESSIONS of Hampden, *Secretary.*

GEORGE F. MILLS of Amherst, *Treasurer pro tempore.*

CHARLES A. GLEASON of New Braintree, *Auditor.*

Committee on Finance and Buildings.*

JAMES S. GRINNELL. HENRY S. HYDE.
J. HOWE DEMOND. SAMUEL C. DAMON.
CHARLES A. GLEASON, *Chairman.*

Committee on Course of Study and Faculty.*

WILLIAM H. BOWKER. ELMER D. HOWE.
FRANCIS H. APPLETON. J. D. W. FRENCH.
WILLIAM WHEELER, *Chairman.*

Committee on Farm and Horticultural Departments.*

ELIJAH W. WOOD. JAMES DRAPER.
JOSEPH A. HARWOOD. MERRITT I. WHEELER.
WILLIAM R. SESSIONS, *Chairman.*

Committee on Experiment Department.*

CHARLES A. GLEASON. ELIJAH W. WOOD.
WILLIAM WHEELER. JAMES DRAPER.
WILLIAM R. SESSIONS, *Chairman.*

Board of Overseers.

STATE BOARD OF AGRICULTURE.

Examining Committee of Overseers.

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GEORGE CRUIKSHANKS, . .	of Fitchburg.
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JOHN BURSLEY, ...	of Barnstable.
A. D. RAYMOND, . . .	of Royalston.

* The president of the college is ex-officio a member of each of the above committees.

The Faculty.

HENRY H. GOODELL, LL.D., *President,*
Professor of Modern Languages.

LEVI STOCKBRIDGE,
Professor of Agriculture, Honorary.

CHARLES A. GOESSMANN, Ph.D., LL.D.,
Professor of Chemistry.

SAMUEL T. MAYNARD, B.Sc.,
Professor of Horticulture.

CHARLES WELLINGTON, Ph.D.,
Associate Professor of Chemistry.

CHARLES H. FERNALD, Ph.D.,
Professor of Zoölogy.

Rev. CHARLES S. WALKER, Ph.D.,
Professor of Mental and Political Science.

WILLIAM P. BROOKS, B.Sc.,
Professor of Agriculture.

GEORGE F. MILLS, M.A.,
Professor of English and Latin.

JAMES B. PAIGE, V.S.,*
Professor of Veterinary Science.

WALTER M. DICKINSON, 1st Lieut. 17th Infantry, U.S.A.,
Professor of Military Science and Tactics.

LEONARD METCALF, B.S.,
Professor of Mathematics and Civil Engineering.

GEORGE E. STONE, Ph.D.,
Professor of Botany.

HERMAN BABSON, B.A.,
Assistant Professor of English.

EDWARD R. FLINT, Ph.D.,
Assistant Professor of Chemistry.

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* On leave.

FRED S. COOLEY, B.Sc.,
Assistant Professor of Agriculture and Farm Superintendent.

RICHARD S. LULL, B.S.,
Assistant Professor of Zoölogy.

RALPH E. SMITH, B.Sc.,
Instructor in German and Botany.

PHILIP B. HASBROUCK, B.S.,
Assistant Professor of Mathematics.

EUGENE H. LEHNERT, V.S.,
Instructor in Veterinary Science.

ROBERT W. LYMAN, LL.D.,
Lecturer on Farm Law.

HENRY H. GOODELL, LL.D.,
Librarian.

Graduates of 1895.*

Ballou, Henry Arthur, . .	West Fitchburg.
Bemis, Waldo Louis, . .	Spencer.
Billings, George Austin (Boston Univ.), ...	South Deerfield.
Brown, William Clay (Boston Univ.), ...	Peabody.
Burgess, Albert Franklin (Boston Univ.), ...	Rockland.
Clark, Harry Edward (Boston Univ.), ...	Wilbraham.
Cooley, Robert Allen (Boston Univ.), ...	South Deerfield.
Crehore, Charles Winfred (Boston Univ.), ...	Chicopee.
Dickinson, Charles Morrison (Boston Univ.), . . .	Chicago, Ill.
Fairbanks, Herbert Stockwell (Boston Univ.), . . .	Amherst.

* The annual report, being made in January, necessarily includes parts of two academic years, and the catalogue bears the names of such students as have been connected with the college during any portion of the year 1895.

Foley, Thomas Patrick (Boston Univ.), ...	Natick.
Frost, Harold Locke (Boston Univ.), ...	Arlington.
Hemenway, Herbert Daniel (Boston Univ.), ...	Williamsville.
Jones, Robert Sharp (Boston Univ.), ...	Dover.
Kuroda, Shiro (Boston Univ.), .	Yamanouchi, Kitamura, Japan.
Lane, Clarence Bronson (Boston Univ.), ...	Killingworth, Conn.
Marsh, Jasper, ...	Danvers Centre.
Morse, Walter Levi (Boston Univ.), ...	Middleborough.
Potter, Daniel Charles (Boston Univ.), ...	Fairhaven.
Read, Henry Blood (Boston Univ.), ...	Westford.
Root, Wright Asahel (Boston Univ.), ...	Deerfield.
Smith, Arthur Bell (Boston Univ.), ...	North Hadley.
Stevens, Clarence Lindon, . .	Sheffield.
Sullivan, Maurice John (Boston Univ.), ...	Amherst.
Tobey, Frederick Clinton (Boston Univ.), ...	West Stockbridge.
Toole, Stephen Peter, . .	Amherst.
Warren, Franklin Lafayette (Boston Univ.), ...	Shirley.
White, Edward Albert (Boston Univ.), ...	Ashby.
Total, ...	28

Senior Class.

Burrington, Horace Clifton, .	Charlemont.
Clapp, Frank Lemuel, . .	Dorchester.
Cook, Allen Bradford, . .	Petersham.
DeLuce, Frank Edmund, . .	Warren.
Edwards, Harry Taylor, . .	Chesterfield.
Fletcher, Stephen Whitcomb, .	Rock.

Hammar, James Fabens, . .	Swampscott.
Harper, Walter Benjamin, . .	Wakefield.
Jones, Benjamin Kent, . .	Middlefield.
Kinney, Asa Stephen, . .	Worcester.
Kramer, Albin Maximilian, .	Clinton.
Leamy, Patrick Arthur, . .	Petersham.
Marshall, James Laird, . .	South Lancaster.
Moore, Henry Ward, . . .	Worcester.
Nichols, Robert Parker, . .	West Norwell.
Nutting, Charles Allen, . .	North Leominster.
Pentecost, William Lewis, . .	Worcester.
Poole, Erford Wilson, . .	North Dartmouth.
Poole, Isaac Chester, . . .	North Dartmouth.
Rawson, Herbert Warren, . .	Arlington.
Read, Frederick Henry, . .	Wilbraham.
Roper, Harry Howard, . .	East Hubbardston.
Saito, Seijiro, ...	Nemuro, Japan.
Sastré de Verand, Salome, . .	Tabasco, Mexico.
Sellew, Merle Edgar, . . .	East Longmeadow.
Shaw, Frederic Bridgman, . .	South Amherst.
Shepard, Lucius Jerry, . .	Oakdale.
Shultis, Newton, . . .	Medford.
Tsuda, George, ...	Tokyo, Japan.
Washburn, Frank Porter, . .	North Perry, Me.
Total, ...	30

Junior Class.

Allen, Harry Francis, . .	Northborough.
Allen, John William, . .	Northborough.
Armstrong, Herbert Julius, .	Sunderland.
Barclay, Frederick White, . .	Kent, Conn.
Barry, John Marshall, . .	Boston.
Bartlett, James Lowell, . .	Salisbury.
Cheney, Liberty Lyon, . .	Southbridge.
Clark, Lafayette Franklin, . .	West Brattleboro', Vt.
Cook, Maurice Elmer, . .	Shrewsbury.
Drew, George Albert, . .	Westford.
Eddy, John Richmond, . .	Boston.
Emrich, John Albert, . .	Amherst.
Goessmann, Charles Ignatius, .	Amherst.
Howe, Herbert Frank, . .	North Cambridge.
King, Charles Austin, . .	East Taunton.
Leavens, George Davison, . .	Brooklyn Heights, N. Y.

Millard, Frank Cowperthwait,	North Egremont.
Norton, Charles Ayer,	Lynn.
Palmer, Clayton Franklin,	Stockbridge.
Peters, Charles Adams,	Worcester.
Sherman, Carleton Farrar,	Jamaica Plain.
Smith, Jr., Philip Henry,	South Hadley Falls.
Walsh, Thomas Francis,	North Amherst.
Total,	23

Sophomore Class.

Adjemian, Avedis Garrabet,	Kharpoot, Turkey.
Baxter, Charles Newcomb,	Quincy.
Charmbury, Thomas Herbert,	Amherst.
Clark, Clifford Gay,	Sunderland.
Eaton, Julian Stiles,	Nyack, N. Y.
Fisher, Willis Sikes,	Ludlow.
Kinsman, Willard Quincy,	Ipswich.
Montgomery, Jr., Alexander,	Natick.
Nickerson, John Peter,	West Harwich.
Thompson, George Harris Austin,	Lancaster.
Warden, Randall Duncan,	Roxbury.
Wiley, Samuel William,	Amherst.
Wolcott, Herbert Raymond,	Amherst.
Wright, George Henry,	Deerfield.
Total,	14

Freshman Class.

Armstrong, William Henry,	Cambridge.
Beaman, Dan Ashley,	Leverett.
Boutelle, Albert Arthur,	Leominster.
Chapin, William Edward,	Chicopee.
Chapman, John Chauncey,	Amherst.
Dana, Herbert Warner,	South Amherst.
Dickinson, Carl Clifton,	South Amherst.
Dutcher, John Remson,	Nyack, N. Y.
Gile, Alfred Dewing,	Worcester.
Hinds, Warren Elmer,	Townsend.
Holt, Henry Day,	Amherst.
Hooker, William Anson,	Amherst.
Hubbard, George Caleb,	Sunderland.
Keenan, George Francis,	Boston.
Maynard, Howard Eddy,	Amherst.

Pingree, Melvin Herbert,	Denmark, Me.	
Smith, Samuel Eldredge,	Middlefield.	
Turner, Frederick Harvey,	Housatonic.	
Walker, Charles Morehouse,	Amherst.	
Wright, Edwin Monroe,	Manteno, Ill.	
Total,		20

Graduates Two-Years Course.

Bagg, Elisha Aaron,	West Springfield.	
Delano, Charles Wesley,	North Duxbury.	
Dutton, Arthur Edwin,	Chelmsford.	
Hooker, William Anson,	Amherst.	
Kinsman, Ernest Eugene,	Heath.	
Rice, Benjamin Willard,	Northborough.	
Sherman, Harry Robinson,	Dartmouth.	
Stearns, Harold Everett,	Conway.	
Sweetser, Frank Eaton,	Danvers.	
Tisdale, Fred Alvin,	North Amherst.	
Todd, Frederick Gage,	Dorchester.	
Wentzell, William Benjamin,	Amherst.	
Total,		12

Second Year.

Alexander, Leon Rutherford,	East Northfield.	
Atkins, Harvey Robbins,	North Amherst.	
Barrett, Frederick Eugene,	Framingham.	
Brainard, Everett Eugene,	Amherst.	
Capen, Elwyn Winslow,	Stoughton.	
Coleman, Robert Parker,	West Pittsfield.	
Courtney, Howard Scholes,	Attleborough.	
Crook, Alfred Clifton,	Portland, Me.	
Davis, John Alden,	East Longmeadow.	
Dickinson, Harry Porter,	Sunderland.	
Eaton, Williams,	North Middleborough.	
Lincoln, Leon Emory,	Taunton.	
Manzanilla, Lorenzo Montore,	Merida, Yucatan, Mexico.	
Pasell, George Walter,	New Bedford.	
Roberts, Percy Colton,	North Amherst.	
Rowe, Henry Simpson,	South Deerfield.	
Stedman, Benjamin,	Chicopee.	
Tisdale, Charles Ernest,	North Amherst.	
Total,		18

First Year.

Ashley, Henry Simeon,	East Longmeadow.	
Blair, Claude Addison,	Amherst.	
Burrington, John Cecil,	Charlemont.	
Canto, José Dolores Boliver,	Cansahcat, Yucatan.	
Canto, Ysidro Herrera,	Cansahcat, Yucatan.	
Chapin, Warren Luther,	East Amherst.	
Colburn, Charles Day,	Westford.	
Dye, Willie Arius,	Sheffield.	
Humphrey, Charles Leonard,	Amherst.	
Isham, John Burt,	Hampden.	
March, Allen Lucas,	Ashfield.	
Merriman, Francis Evander,	Boston.	
Pendleton, Charles Bemis,	Willimansett.	
Perry, Edward King,	Brookline.	
Sastré de Verand, César,	Tabasco, Mexico.	
Sharpe, Edward Hewett,	Northfield.	
Smith, Bernard Howard,	Middlefield.	
Smith, Carl William,	Melrose.	
Stacy, Clifford Eli,	Gloucester.	
Total,		19

Graduate Course.

For Degree of M.S.

Carpenter, Malcolm Austin (B.Sc. 1891),	Leyden.	
Kirkland, Archie Howard (B.Sc. 1894),	Norwich.	
Smith, Frederic Jason (B.Sc. 1890),	North Hadley.	
Total,		3

Resident Graduates at the College and Experiment Station.

Arnold, B.Sc., Frank Luman (Boston Univ.),	Belchertown.
Crocker, B.Sc., Charles Stoughton (Boston Univ.),	Sunderland.
Haskins, B.Sc., Henri Darwin (Boston Univ.),	North Amherst.

Holland, B.Sc., Edward Bertram (Boston Univ.), . . .	Amherst.
Johnson, B.Sc., Charles Henry (Boston Univ.), . . .	Prescott.
Putnam, B.Sc., Joseph Harry (Boston Univ.), . . .	West Sutton.
Shepardson, B.Sc., William Martin (Boston Univ.), . .	Warwick.
Smith, B.Sc., Robert Hyde (Boston Univ.), ...	Amherst.
Stone, B.Sc., Almon Humphrey (Boston Univ.), . . .	Phillipston.
Thomson, B.Sc., Henry Martin (Boston Univ.), . . .	Monterey.
Todd, Frederick Gage, . .	Dorchester.
White, B.Sc., Edward Albert (Boston Univ.), . . .	Ashby.

Total, ... 12

Summary.

Graduate course: —		
For degree of M.S.,	3	
Four-years course: —		
Graduates of 1895,	28	
Senior class,	30	
Junior class,	23	
Sophomore class,	14	
Freshman class,	20	
Two-years course: —		
Graduates of 1895,	12	
Second year,	18	
First year,	19	
Resident graduates,	12	
Total,		179
Entered twice,		3
Total,		176

FOUR-YEARS COURSE OF STUDY.

FRESHMAN YEAR.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, . .	- - -	Botany, structural, — 5.	- - -	- - -	Advanced algebra, — 5. Book-keeping, — 2.	English, — 2.	French, — 4.	Study of tactics, — 1.
Winter, .	History of agriculture, soils and soil formation, — 4.	- - -	- - -	- - -	Advanced algebra and geometry (plane), — 4.	English, — 2.	French, — 4.	Mechanical drawing, — 6.
Summer, .	Soils: — characteristics, improvement of, drainage, etc., — 4.	Botany, analytical, — 4.	Lectures in elementary chemistry, — 3.	- - -	Geometry (solid), — 3.	English, — 2.	French, — 3.	- -

SOPHOMORE YEAR.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, . .	Irrigation, disposition of sewage, manures and fertilizers, — 4.	Botany, economic, and laboratory work, — 4.	Lectures in elementary chemistry, — 4.	- - -	Trigonometry, — 3.	English, — 2.	- -	- -
Winter, .	- - -	Laboratory work, — 4.	Lectures and practice, — 4.	Anatomy and physiology, — 4.	Surveying, — 3.	English, — 2.	- -	Mechanical drawing, — 4.
Summer, .	Relations of the atmosphere to plant-life, mowings, pastures, grasses, ensilage, — 5.	Horticulture, — 5.	Dry and humid qualitative analysis, — 3.	- - -	Surveying, — 4.	English, — 2.	- -	- -

Junior Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Zoölogy.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, . .	Field crops, seed raising, production and improvement of varieties, machines and implements, — 4.	Market gardening, — 3.	Qualitative analysis, — 5.	Zoölogy, laboratory work, — 8.	Physics, — 2.	Rhetoric and composition, — 4.	- -	- -
Winter, .	Breeds and breeding of live stock, poultry farming, — 2.	- - -	Lectures and practice in organic chemistry, — 6.	Zoölogy, — 3.	Physics, — 3.	- -	English literature, — 4.	Descriptive geometry, — 4.
Summer, .	- - -	Landscape gardening, — 5.	The same continued, — 5.	Entomology, — 6.	Physics, — 4.	English, — 2.	- -	- -

Senior Year (Elective).*

	Agriculture.	Botany and Horticulture.	Chemistry.	Zoölogy.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, . .	Dairy farming, — 5.	Botany, cryptogamic, — 8.	Chemical physics and quantitative analysis, — 8.	Entomology, — 8. Veterinary science, — 5.	Engineering, — 5. Analytical geometry, — 5.	English, — 2. Advanced English, — 5. Latin, — 5.	Political economy, — 5. German, — 5.	Military science, — 1.
Winter, .	Cattle feeding, — 5.	Botany, cryptogamic, — 8.	Advanced work with lectures, — 8.	Entomology, — 8. Veterinary science, — 5.	Engineering, — 5. Differential calculus, — 5.	English, — 2. Advanced English, — 5. Latin, — 5.	Political economy, — 5. German, — 5.	Military science, — 1. Law lectures, — 1.
Summer, .	Experimental work in agriculture, — 5.	Botany, physiological, — 8.	The same continued, — 8.	Entomology, — 8. Veterinary science, — 5.	Engineering, — 5. Integral calculus, — 5.	English, — 2. Advanced English, — 5. Latin, — 5.	Constitutional history, — 5. German, — 5.	Military science, — 1.

* English and military science are required; of the other studies three at least must be chosen.

SHORT WINTER COURSES.

[All courses optional.]

AGRICULTURE.

I. General Agriculture.	
1. Soils and operations upon them, drainage, irrigation, etc.,	10
2. Farm implements and machinery,	5
3. Manures and fertilizers,	10
4. Crops of the farm, characteristics, management, etc.,	10
5. Crop rotation,	2
6. Farm book-keeping,	5
7. Agricultural economics,	11
8. Farm, dairy and poultry management,	11
Total hours,	64

II. Animal Husbandry.	
1. Introduction,	1
2. Location and soil,	2
3. Building,	4
4. Breeds of cattle,*	10
5. Breeds of horses,	6
6. Grain and fodder crops,*	11
7. Foods and feeding,*	11
8. Extra,	19
Total hours,	64

* With dairy course.

DAIRYING.

III. Lectures and Class-room Work.	
1. The soil and crops,	22
2. The dairy breeds and cattle breeding,	22
3. Stable construction and sanitation, care of cattle,	11
4. Common diseases of stock, their prevention and treatment,	11
5. Foods and feeding,	11
6. Book-keeping for the dairy farm and butter factory,	22
7. Pasteurization and preparation of milk on physicians' prescriptions,	11
III. Lectures, etc. — Concluded.	
8. Composition and physical peculiarities of milk; conditions which affect creaming, churning, methods of testing and preservation,	22
9. Milk testing,	6
10. Butter making,	12
11. Practice in aeration, pasteurization,	6
Total hours,	156

HORTICULTURE.

IV. Fruit Culture.	
1. Introduction,	1
2. Propagation of fruit trees by seed, budding, grafting, forming the head, digging, planting, pruning, training, cultivation, etc.,	28
3. Insects and fungous diseases,	3
Total hours,	32

V. Floriculture.	
1. Greenhouse construction and heating,	6
2. Propagation of greenhouse and other plants by seed, cuttings, grafting, etc.,	3
3. Cultivation of rose, carnation, chrysanthemum and orchids,	12
4. Propagation and care of greenhouse and bedding plants,	10
V. Floriculture — Concluded.	
5. Insects and fungi which attack greenhouse plants,	2
Total hours,	33

VI. Market Gardening.	
1. Introduction, equipment, tools, manures, fertilizers, etc.,	3
2. Greenhouse construction and heating,	6
3. Forcing vegetables under glass,	3
4. Seed growing by the market gardener,	3
5. Special treatment required by each crop,	10
6. Insects and fungi, with remedies,	2
Total hours,	27

Botany.

VII. Lectures on Injurious Fungi of the Farm, Garden, Greenhouse, Orchard and Vineyard.

1.	Introduction,	2
2.	Nature and structure of rusts,	4
3.	Nature and structure of smuts,	4
4.	Nature and structure of mildews,	4
5.	Nature and structure of rots,	4
6.	Beneficial fungi of roots,	2
7.	Edible mushrooms,	2
	Total hours,	22

VIII. Lectures and Demonstrations on "How Plants Grow."

1.	Introduction,	1
2.	The parts of a plant,	1
3.	Structure of the cell and plant in general,	3
4.	Functions of root, stem and leaves,	3
5.	Food of plant obtained from air,	3
6.	Food of plant obtained from soil,	3
7.	Transference and elaboration of food,	2
8.	Growth of plants,	2
9.	Effects of light, moisture, heat and cold,	2
10.	Root tubercles on pea and clover,	1
11.	Cross fertilization of flowers,	1
	Total hours,	22

Chemistry.

IX. General Agricultural Chemistry.

1.	Introduction,	2
2.	The fourteen elements of agricultural chemistry,	1
3.	Rocks and soils,	8
4.	The atmosphere,	7
5.	The chemistry of crop growing,	8
6.	Fertilizers,	8
7.	Animal chemistry,	8
	Total hours,	55

X. Chemistry of the Dairy.

1.	Introduction,	2
2.	The fourteen elements of agricultural chemistry,	14
3.	The physical properties of milk,	13
4.	Analysis of milk, butter, cheese and other dairy products,	13
5.	Chemistry of the manufacture of dairy products,	13
	Total hours,	55

Zoölogy.

XI. Animal Life on the Farm.

Total hours, ... 22

XII. Insect Friends and Foes of the Farmers.

Total hours, ... 33

GRADUATE COURSE.

1. Honorary degrees will not be conferred.

2. Applicants will not be eligible to the degree of M.S. until they have received the degree of B.S. or its equivalent.

3. The faculty shall offer a course of study in each of the following subjects: mathematics and physics; chemistry; agriculture; botany; horticulture; entomology; veterinary. Upon the satisfactory completion of any two of these the applicant shall receive the degree of M.S. This prescribed work may be done at the Massachusetts Agricultural College or at any institution which the applicant may choose; but in either case the degree shall be conferred only after the applicant has passed an examination at the college under such rules and regulations as may be prescribed.

4. Every student in the graduate course shall pay one hundred dollars to the treasurer of the college before receiving the degree of M.S.

TEXT-BOOKS.

WOOD — "The American Botanist and Florist."
BESSEY — "Botany for High Schools and Colleges."
GRAY — "Manual."
GRAY — "Structural Botany."
BOWER — "Practical Botany."
ARTHUR, BARNES and COULTER — "Plant Dissection."
CAMPBELL — "Structural and Systematic Botany."
OEL — "Experimental Plant Physiology."
GOODALE — "Physiological Botany."
DARWIN and ACTON — "Practical Physiology of Plants."
SCRIBNER — "Fungous Diseases of the Grapevine."
VASEY — "Agricultural Grasses of the United States."
SMITH — "Diseases of Garden Crops."
WOLLE — "Fresh-water Algæ."
LONG — "How to make the Garden pay."
LONG — "Ornamental Gardening for Americans."
TAFT — "Greenhouse Construction."
WEED — "Insects and Insecticides."
WEED — "Fungi and Fungicides."
FULLER — "Practical Forestry."
MAYNARD — "Practical Fruit Grower."
MCALPINE — "How to know Grasses by their Leaves."
MORTON — "Soil of the Farm."
GREGORY — "Fertilizers."

MILLS and SHAW — "Public School Agriculture."
MILES — "Stock Breeding."
ARMSBY — "Manual of Cattle Feeding."
CURTIS — "Horses, Cattle, Sheep and Swine."
MORROW and HUNT — "Soils and Crops."
GROTENFELD — "The Principles of Modern Dairy Practice."
SHEPARD — "Elementary Chemistry."
STORER — "Agriculture in its Relations to Chemistry."
RICHTER and SMITH — "Text-book of Inorganic Chemistry."
MUTER — "Analytical Chemistry."
ROSCOE — "Lessons in Elementary Chemistry."
BERNTHSEN and McGOWAN — "Text-book of Organic Chemistry."
FRESENIUS — "Qualitative Chemical Analysis."
FRESENIUS — "Quantitative Chemical Analysis."
REYNOLDS — "Experimental Chemistry."
SUTTON — "Volumetric Analysis."
DANA — "Manual of Determinative Mineralogy."
THOMSON — "Commercial Arithmetic."
MESERVEY — "Book-keeping."
WELLS — "College Algebra."
DANA — "Mechanics."
WELLS — "Plane and Solid Geometry" (revised edition).
RUNKLE — "Plane Analytic Geometry."
BOWSER — "Analytic Geometry."
OSBORNE — "Differential and Integral Calculus."
WELLS — "Essentials of Trigonometry."
JOHNSON — "Theory and Practice of Surveying."
BYRNE — "Highway Construction."
JONES — "Sound, Light and Heat."
THOMPSON — "Electricity and Magnetism."
AYRTON — "Practical Electricity."
LOOMIS — "Meteorology."
MARTIN — "Human Body" (elementary course).
MARTIN — "Human Body" (briefer course).
WALKER — "Political Economy" (abridged edition).
GIDE — "Principles of Political Economy."
WILSON — "The State, Historical and Practical Politics."
WHITNEY and LOCKWOOD — "English Grammar."
LOCKWOOD — "Lessons in English."
GENUNG — "Outlines of Rhetoric."
SPRAGUE — "Six Selections from Irving's Sketch-book"
WHITTIER, No. 4; LONGFELLOW, Nos. 33, 34, 35; LOWELL, No. 39 — "Riverside Literature Series."
HUDSON — "Selections of Prose and Poetry." Webster, Burke, Addison, Goldsmith, Shakespeare.
PAINTOR — "English Literature."
WHITNEY — "French Grammar."
LUQUIENS — "Popular Science."
WHITNEY — "German Grammar."

BOISEN — "Preparatory German Prose."
BERNHARDT — "Sprach-und Lesebuch."
HODGES — "Scientific German."
WHITE — "Progressive Art Studies."
FAUNCE — "Mechanical Drawing."
U. S. ARMY — "Infantry Drill Regulations"
U. S. ARMY — "Artillery Drill Regulations."

To give not only a practical but a liberal education is the aim in each department, and the several courses have been so arranged as to best subserve that end. Weekly exercises in composition and declamation are held throughout the course. The instruction in agriculture and horticulture is both theoretical and practical, the lessons of the recitation room being practically enforced in the garden and field. Students are allowed to work for wages during such leisure hours as are at their disposal. Under the act by which the college was founded, instruction in military tactics is imperative, and each student, unless physically debarred,* is required to attend such exercises as are prescribed, under the direction of a regular army officer stationed at the college.

FOUR-YEARS COURSE.

ADMISSION.

Candidates for admission to the freshman class will be examined, orally and in writing, upon the following subjects: English grammar, geography, United States history, physiology, physical geography, arithmetic, the metric system, algebra (through quadratics), geometry (two books) and civil government (Mowry's "Studies in Civil Government"). The standard required is 65 per cent on each paper. Diplomas from high schools will *not* be received in place of examination. Examination in the following subjects may be taken a year before the candidate expects to enter college: English grammar, geography, United States history, physical geography and physiology. Satisfactory examination in a substantial part of the subjects offered will be required, that the applicant may have credit for this preliminary examination.

Candidates for higher standing are examined as above, and also in the studies gone over by the class to which they desire admission.

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* Certificates of disability must be procured of Dr. Herbert B. Perry of Amherst.

No one can be admitted to the college until he is sixteen years of age. The regular examinations for admission are held at the Botanic Museum, at 9 o'clock A.M., on Thursday and Friday, June 18 and 19, and on Tuesday and Wednesday, September 1 and 2; but candidates may be examined and admitted at any other time in the year. For the accommodation of those living in the eastern part of the State, examinations will also be held at 9 o'clock A.M., on Thursday and Friday, June 18 and 19, at Jacob Sleeper Hall, Boston University, 12 Somerset Street, Boston; and for the accommodation of those in the western part of the State, at the same date and time, at the Sedgwick Institute, Great Barrington, by James Bird. Two full days are required for examination, and candidates must come prepared to stay that length of time.

TWO-YEARS COURSE.

At the regular annual meeting of the trustees, held Dec. 31, 1895, the following votes were passed: —

That the two-years course be discontinued, with the understanding that those who have already entered upon it be allowed to complete the same.

That short winter courses of eleven weeks, in agriculture, botany, chemistry, dairying, floriculture, horticulture, market gardening and zoölogy, be established after the close of the present collegiate year.

That a special course in dairying be established Jan. 1, 1896.

WINTER COURSES.

For these short winter courses examinations are not required. They commence the first Wednesday in January and end the third Wednesday in March. Candidates must be at least sixteen years of age. The doors of the college are opened to applicants from both sexes. The same privileges in regard to room and board will obtain as with other students. Attendance upon general exercises is required. Residents of the State will be required to pay the usual fees for apparatus and material used in laboratory work. Those not residents of the State will be required to pay, in addition, a tuition fee.

ENTRANCE EXAMINATION PAPERS USED IN 1895.

The standard required is 65 per cent on each paper.

Four-years Course.

Arithmetic and the Metric System.

1. Write the prime numbers between 1 and 20. Write in Roman notation 1,659.

2. What is the greatest common divisor of 126, 210, 252?

3. $\frac{3}{4}+\frac{1}{5}+1\frac{1}{8}-1\frac{5}{6}=?$

4. At 20 cents per square inch, what will be the cost of 3 square yards, 1 square foot and 9 square inches of gold leaf?

5. If $\frac{4}{9}$ of a farm sold for $\frac{5}{8}$ of what it cost, what is the gain per cent?

6. What is the bank discount of $586 for 3 months at 6 per cent? What are the proceeds?

7. If 8 men can dig a ditch 60 feet long, 8 feet wide and 6 feet deep in 15 days, how many days will 24 men require to dig a ditch 80 feet long, 3 feet wide and 8 feet deep?

8. What is the square root of 62,001?

9. Name the three principal units of the metric system, and give their English equivalents.

10. Express the sum of the following in metres: 9.5 K.m., 37 D.m., 6.347 H.m., 378.6 cm.

11. In 387 cm. how many feet?

12. How much will it cost to fence a hectare of land that is in the form of a square, at 10 cents per metre?

Algebra.

1. What are the prime factors of $14x^2+29x-15$? of $(a+b)^2-c^2$?

2. $\left(\frac{x^5+2x^4y-x^2y^3+3x^3y^2-3y^5-2xy^4}{x^3-y^3}\right)=?$

3. Solve for x and y in, $\frac{5}{x}+\frac{16}{y}=79$ and $\frac{16}{x}-\frac{1}{y}=44$.

4. $\sqrt[3]{27+108x+90x^2-80x^3-60x^4+48x^5-8x^6}=?$

5. Expand $(3a^2+4b^3)^5$.

6. Rationalize $\frac{\sqrt{x^2+1}+\sqrt{x^2-1}}{\sqrt{x^2+1}-\sqrt{x^2-1}}+\frac{\sqrt{x^2+1}-\sqrt{x^2-1}}{\sqrt{x^2+1}+\sqrt{x^2-1}}$.

7. $x+\sqrt{1+x^2}=\frac{2}{\sqrt{1+x^2}}$ solve for x.

8. Solve for x and y.

$$x^2+xy-2y^2=-44$$
$$xy+3y^2=80.$$

Geometry.

1. What is a scalene triangle, an isosceles triangle, an equiangular triangle?

2. What is the complement of an angle? A supplement of an angle? Find the complement of 35°, of $47\frac{1}{2}$°; find the supplement of 10° 29′, of 144°.

Prove the following: —

3. If oblique lines be drawn from a point to a straight line, two equal oblique lines cut off equal distances from the foot of the perpendicular from the point to the line.

4. The sum of the angles of any triangle is equal to two right angles.

5. Any point in the bisector of an angle is equally distant from the sides of the angle.

6. In the same circle or equal circles chords equally distant from the centre are equal.

7. The two tangents to a circle from an outside point are equal.

8. The angle between a tangent and a chord is measured by $\frac{1}{2}$ of its intercepted arc.

United States History.

NOTE. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. What were the causes of the founding of the colony at Jamestown in Virginia in 1607?

2. Tell what you know about Roger Williams.

3. What were the causes of the Revolution? Give the dates of this war, and name three important battles in it.

4. Who was John Paul Jones?

5. Tell of the part played by our navy in the War of 1812. What ship that took part in this war, on the American side, is afloat to-day?

6. Give the date of the Missouri compromise, and tell what it was.

7. What has been the condition of the South since the Civil War?

8. What important event in our history is to be associated with each of the following names: Quebec, Plymouth, Philadelphia, Charleston, West Point?

9. Name five great American generals; five great American naval commanders.

10. What important questions are now before our government?

Geography.

Note. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Draw a map of New England, and locate on it the following: the boundaries of each State, the White Mountains, Boston, Hartford, Gloucester, Augusta, Burlington, Springfield, Merrimac River, Connecticut River.

2. What is the largest desert in the world? the largest island? the highest mountain?

3. Name the Great Lakes in the order of their size, and state upon which of them the following cities are placed: Chicago, Niagara, Toronto, Detroit.

4. Name the political divisions of the Dominion of Canada.

5. Locate Madagascar, Tokyo, Cape Town, Nicaragua, Edinburgh, Hamburg, Poland.

6. What country has the largest system of railroads? The largest foreign commerce? The largest united area? The largest population?

7. Describe the United Kingdom of Great Britain, telling of its (*a*) divisions, (*b*) geographical features, (*c*) products.

8. Name the oceans in the order of their size. What part of the earth's surface does the water cover?

9. Define strait, peninsula, water-shed, lake, harbor.

10. What kind of a government has England? France? Russia? Brazil? Turkey?

Physical Geography.

Note. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Define physical geography.

2. What is the exact form of the earth? Give the proportion of land and water.

3. Define erosion, alluvial plain, delta, cañon.

4. What is a glacier? Define the terms lateral moraine, terminal moraine.

5. Can rivers and glaciers be compared? How? Have they a similar action on the earth's surface?

6. What are ocean currents? Name some. Give some causes.

7. Give two methods of mountain forming. Give examples of mountain ranges formed by each method.

8. What is climate? Give some causes which influence climate.

9. How are coral islands formed? Define an atoll, barrier reef, fringing reef.

10. What is a volcano? Where are they principally found?

Civil Government.

NOTE. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Why is any government necessary in the United States to-day?

2. Who make the laws for the government of the town in which you live? for the State? for the nation?

3. Name three kinds of colonial governments found in America prior to the Revolution, and the colonies that were under each.

4. When did the American republic, with its national organization, commence? When did the States cease to be colonies and become States?

5. In what body was the government vested during most of the Revolutionary War? What were the Articles of Confederation?

6. In what year was the Constitution of the United States framed? In what year did it go into effect? Where was the first President inaugurated?

7. Into what departments is the government of the United States divided? State the length of the term of office of the following: a member of the National House of Representatives; the President of the United States; a United States Senator?

8. Of how many members does the United States Senate now consist? Who is its presiding officer? Name the United States Senators from Massachusetts.

9. What is the title of the chief executive officer (or officers) of the town? of the State? of the nation?

10. Define the word *citizen*.

Physiology.

NOTE. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Define hygiene, anatomy, physiology.
2. What is a cell? a tissue? an organ?
3. Name the bones of the leg. Compare them with those of the arm.
4. What is a muscle? How do muscles bring about movement between bones?
5. Give uses of the skin, the kidneys.
6. Define digestion, absorption, assimilation.
7. Describe the alimentary tract.
8. What is the blood? Give its uses. What is lymph?
9. What is the brain? Name the different parts. What is the special function of each?
10. What is a man? What is his place in nature?

English Grammar and Composition.

NOTE. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. State *clearly* and *briefly* what preparation you have had in grammar and rhetoric, naming, if possible, the text-books.

2. Write a simple sentence, a compound sentence, a complex sentence.

3. Name the parts of speech, define each, and give examples of each.

4. Correct the following, *stating reasons:* —

(*a*) You and me will admire our supper.

(*b*) The opinion of a thousand men were against him.

(*c*) Charles can draw the roundest circle I ever see.

(*d*) "Did the boss jump on you?"
"Well, I should smile!"
"You're not onto his little job, are you?"
"You bet your hat I am!"

(*e*) The boat was anchored at the wharf, and we got in and the rope was untied so that the oars could be placed in the row-locks which were fastened to this rope.

5. Compare beautiful, honest, bitter, deep, awful.

6–10. Put the following poem into good English prose, neither omitting nor adding anything: —

At anchor in Hampton Roads we lay,
On board of the "Cumberland," sloop-of-war;
And at times from the fortress across the bay
The alarum of drums swept past,
Or a bugle blast
From the camp on the shore.

Then far away to the south uprose
A little feather of snow-white smoke,
And we knew that the iron ship of our foes
Was steadily steering its course
To try the force
Of our ribs of oak.

Down upon us heavily she runs,
Silent and sullen, the floating fort.
Then comes a puff of smoke from her guns,
And leaps the terrible death
With fiery breath
From each open port.

We are not idle, but send her straight
Defiance back in a full broadside.
As hail rebounds from a roof of slate,
Rebounds our heavier hail
From each iron scale
Of the monster's hide.

. . . .

Then like a Kraken huge and black,
She crushed our ribs in her iron grasp.
Down went the "Cumberland" all a wrack,
With a sudden shudder of death,
And the cannon's breath
For her dying gasp.

DEGREES.

Those who complete the four-years course receive the degree of Bachelor of Science, the diploma being signed by the governor of Massachusetts, who is the president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and upon graduation receive its diploma in addition to that of the college, thereby becoming entitled to all the privileges of its alumni.

Those completing the graduate course receive the degree of Master of Science. A certificate signed by the president of the college will be awarded to those completing the two-years course.

EXPENSES.

Tuition in advance: —			
Fall term,	$30 00		
Winter term,	25 00		
Summer term,	25 00		
		$80 00	$80 00
Room rent, in advance, $8 to $16 per term,		24 00	48 00
Board, $2.50 to $5 per week,		95 00	190 00
Fuel, $5 to $15,		5 00	15 00
Washing, 30 to 60 cents per week,		11 40	22 80
Military suit,		15 75	15 75
Expenses per year,		$231 15	$371 55

Board in clubs has been about $2.45 per week; in private families, $4 to $5. The military suit must be obtained immediately upon entrance at college, and used in the drill exercises prescribed. The following fees will be charged for the maintenance of the several laboratories: chemical, $10 per term used; zoölogical, $4 per term used; botanical, $1 per term used by sophomore class, $2 per term used by senior class; entomological, $2 per term used. Some expense will also be incurred for lights and text-books. Students whose homes are within the State of Massachusetts can in most cases obtain a scholarship by applying to the senator of the district in which they live.

THE LABOR FUND.

The object of this fund is to assist those students who are dependent either wholly or in part on their own exertions, by furnishing them work in the several departments of the college. The greatest opportunity for such work is found in the agricultural and horticultural departments. Application should be made to Profs. William P. Brooks and Samuel T. Maynard, respectively in charge of said departments. Students desiring to avail themselves of its benefits must bring a certificate signed by one of the selectmen of the town in which they are resident, certifying to the fact that they require aid.

ROOMS.

All students, except those living with parents or guardians, will be required to occupy rooms in the college dormitories.

For the information of those desiring to carpet their rooms, the

following measurements are given: in the new south dormitory the study rooms are about fifteen by fourteen feet, with a recess seven feet four inches by three feet; and the bedrooms are eleven feet two inches by eight feet five inches. This building is heated by steam. In the north dormitory the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet. The inside rooms are thirteen and one-half by fourteen and one-half feet, and the bedrooms eight by eight feet. A coal stove is furnished with each room. Aside from this, all rooms are unfurnished. Mr. Thomas Canavan has the general superintendence of the dormitories, and all correspondence relative to the engaging of rooms should be with him.

SCHOLARSHIPS.

Established by Private Individuals.

Mary Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield.

Whiting Street Fund of one thousand dollars, the bequest of Whiting Street, Esq., of Northampton.

Henry Gassett Fund of one thousand dollars, the bequest of Henry Gassett, Esq., of North Weymouth.

The income of the above funds is assigned by the faculty to worthy students requiring aid.

CONGRESSIONAL SCHOLARSHIPS.

The trustees voted in January, 1878, to establish one free scholarship for each of the congressional districts of the State. Application for such scholarships should be made to the representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Applicants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course, and then engaging in some pursuit connected with agriculture.

STATE SCHOLARSHIPS.

The Legislature of 1883 passed the following resolve in favor of the Massachusetts Agricultural College: —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide for the students of said institution the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually, for the term of four years, eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place as the senator then in office from each district shall designate; and the said scholarships shall be assigned equally to each senatorial district. But, if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible; but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as hereinbefore provided.

The Legislature of 1886 passed the following resolve, making perpetual the scholarships established: —

Resolved, That annually the scholarships established by chapter forty-six of the resolves of the year eighteen hundred and eighty-three be given and continued in accordance with the provisions of said chapter.

In accordance with these resolves, any one desiring admission to the college can apply to the senator of his district for a scholarship. Blank forms of application will be furnished by the president.

EQUIPMENT.

Agricultural Department.

The Farm. — Among the various means through which instruction in agriculture is given, none exceeds in importance the farm. The part which is directly under the charge of the professor of agriculture comprises about one hundred and fifty acres of im-

proved land and thirty acres of woodland. Of the improved land, about thirty acres are kept permanently in grass. A considerable part of this is laid off in half and quarter acre plats, and variously fertilized with farm-yard and stable manures and chemicals, with a view to throwing light upon the economical production of grass. These plats are staked and labelled, so that all may see exactly what is being used and what are the results.

The rest of the farm is managed under a system of rotation, all parts being alternately in grass and hoed crops. All the ordinary crops of this section are grown, and many not usually seen upon Massachusetts farms find a place here. Our large stock of milch cows being fed almost entirely in the barn, fodder crops occupy a prominent place. Experiments of various kinds are continually under trial; and every plat is staked, and bears a label stating variety under cultivation, date of planting, and manures and fertilizers used.

Methods of land improvement are constantly illustrated here, tile drainage especially receiving a large share of attention. There are now some nine miles of tile drains in successful and very satisfactory operation upon the farm. Methods of clearing land of stumps are also illustrated, a large amount of such work having been carried on during the last few years.

In all the work of the farm the students are freely employed, and classes are frequently taken into the fields; and to the lessons to be derived from these fields the students are constantly referred.

The Barn and Stock. — Our commodious barns contain a large stock of milch cows, many of which are grades; but the following pure breeds are represented by good animals, viz., Holstein-Friesian, Ayrshire, Jersey, Guernsey and Shorthorn. Experiments in feeding for milk and butter are continually in progress. We have a fine flock of Southdown sheep and a few choice specimens of the Shropshire, Horned Dorset, Cotswold and Merino breeds. Swine are represented by the Chester White, Poland China, Middle Yorkshire and Tamworth breeds. Besides work horses, we have a number of pure-bred Percherons, used for breeding as well as for work.

The barn is a model of convenience and labor-saving arrangements. It illustrates different methods of fastening animals, various styles of mangers, watering devices, etc. Connected with it are a plant for electric light and power and commodious storage rooms for vehicles and machines. It contains silos and a granary. A very large share of the work is performed by students, and whenever points require illustration, classes are taken to it for that purpose.

Dairy School. — Connected with the barn is a wing providing accommodation for practical and educational work in dairying. The wing contains one room for heavy dairy machinery, another for lighter machinery, both large enough to accommodate various styles of all prominent machines; a large ice house, a cold-storage room and a room for raising cream by gravity methods, a class room and a laboratory. The power used is an electric motor. This department is steam heated and piped for hot and cold water and steam. In this department has been placed a full line of modern dairy machinery, so that we are able to illustrate all the various processes connected with the creaming of milk, its preparation for market and the manufacture of butter. Special instruction in such work is offered in the dairy course.

Equipment of Farm. — Aside from machines and implements generally found upon farms, the more important of those used upon our farm and in our barn which it seems desirable to mention are the following: reversible sulky plough, broadcast fertilizer distributer, manure spreader, grain drill, horse corn planter, potato planter, wheelbarrow grass seeder, hay loader, potato digger, hay press, fodder cutter and crusher and grain mill. It is our aim to try all novelties as they come out, and to illustrate everywhere the latest and best methods of doing farm work.

Lecture Room. — The agricultural lecture room in south college is well adapted to its uses. It is provided with numerous charts and lantern slides, illustrating the subjects taught. Connected with it are two small rooms at present used for the storage of illustrative material, which comprises soils in great variety, all important fertilizers and fertilizer materials, implements used in the agriculture of our own and other countries, and a collection of grasses and forage plants, grains, etc.

A valuable addition to our resources consists of a full series of Landsberg's models of animals. These are accurate models of selected animals of all the leading breeds of cattle, horses, sheep and swine, from one-sixth to full size, according to subject. We are provided with a complete collection of seeds of all our common grasses and the weeds which grow in mowings, and have also a large collection of the concentrated food stuffs. All these are continually used in illustration of subjects studied.

Museum. — An important beginning has been made towards accumulating materials for an agricultural museum. This is to contain the rocks from which soils have been derived, soils, fertilizer materials and manufactured fertilizers, seeds, plants and their products, stuffed animals, machines and implements. It is expected to make this collection of historical importance by includ-

ing in it old types of machines and implements, earlier forms of breeds, etc. For lack of room the material thus far accumulated is stored in a number of scattered localities, and much of it where it cannot be satisfactorily exhibited.

Botanic Department.

Course of Study. — This department is well equipped to give a comprehensive course in most of the subjects of botany. The course aims to treat of all the more important features connected with the study of plants which have a close bearing upon agriculture, without at the same time deviating from a systematic and logical plan. Throughout the entire course the objective methods of teaching are followed, and the student is constantly furnished with an abundance of plant material for practical study, together with an elaborate series of preserved specimens for illustration and comparison. In the freshman year the study of structural and systematic botany is pursued, with some observation on insect fertilization. This is followed in the first term of the sophomore year by the systematic study of grasses, trees and shrubs, and this during the winter term by an investigation into the microscopic structure of the plant. The senior year is given up entirely to cryptogamic and physiological botany.

The Botanic Museum contains the Knowlton herbarium, of over ten thousand species of phanerogamous and the higher cryptogamous plants; about five thousand species of fungi, and several collections of lichens and mosses, including those of Tuckerman, Frost, Denslow, Cummings, Müller and Schaerer. It also contains a large collection of native woods, cut so as to show their individual structure; numerous models of native fruits; specimens of abnormal and peculiar forms of stems, fruits, vegetables, etc.; many interesting specimens of unnatural growths of trees and plants, natural grafts, etc.; together with models for illustrating the growth and structure of plants, and including a model of the squash which raised by the expansive force of its growing cells the enormous weight of five thousand pounds.

The Botanic Lecture Room, in the same building, is provided with diagrams and charts of over three thousand figures, illustrating structural, systematic and physiological botany.

The Botanic Laboratory, with provision for twenty-five students to work at one time, is equipped with Leitz', Reichert's, Bausch and Lomb's, Beck's, Queen's and Tolles' compound microscopes, with objectives varying from four inch to one-fifteenth inch focal length, and also with a few dissecting microscopes. It also con-

tains a DuBois Raymond induction apparatus, a Thoma and a Beck microtome, a self-registering thermometer, a Wortmann improved clinostat and also one of special construction, an Arthur centrifugal apparatus with electric motor, a Pfeffer-Baranetzky electrical self-registering auxanometer, a Sach's arc-auxanometer, a horizontal reading microscope (Pfeffer model), various kinds of dynamometers of special construction, respiration appliances, mercurial sap and vacuum gauges, manometers, gas and exhaust chambers, a Bausch and Lomb micro-photographic camera, a Clay landscape camera and dark closet fitted for work, besides various other appliances for work and demonstration in plant physiology.

Horticultural Department.

Greenhouses. — To aid in the instruction of botany, as well as that of floriculture and market gardening, the glass structures contain a large collection of plants of a botanical and economic value, as well as those grown for commercial purposes. They consist of a large octagon, forty by forty feet, with sides twelve feet high and a central portion over twenty feet high, for the growth of large specimens, like palms, tree ferns, the bamboo, banana, guava, olive, etc.; a lower octagon, forty by forty feet, for general greenhouse plants; a moist stove, twenty-five feet square; a dry stove of the same dimensions; a rose room, twenty-five by twenty feet; a room for aquatic plants, twenty by twenty-five feet; a room for ferns, mosses and orchids, eighteen by thirty feet; a large propagating house, fifty by twenty-four feet, fitted up with benches sufficient in number to accommodate fifty students at work at one time; a vegetable house, forty-two by thirty-two feet; two propagating pits, eighteen by seventy-five feet, each divided into two sections for high and low temperatures, and piped for testing overhead and under-bench heating; a cold grapery, eighteen by twenty-five feet. To these glass structures are attached three workrooms, equipped with all kinds of tools for greenhouse work. In building these houses as many as possible of the principles of construction, heating, ventilating, etc., have been incorporated for the purposes of instruction.

Orchards. — These are extensive, and contain nearly all the valuable leading varieties, both old and new, of the large fruits, growing under various conditions of soil and exposure.

Small Fruits. — The small fruit plantations contain a large number of varieties of each kind, especially the new and promising ones, which are compared with older sorts, in plots and in field culture. Methods of planting, pruning, training, cultivation,

study of varieties, gathering, packing and shipping fruit, etc., are taught by field exercises, the students doing a large part of the work of the department.

Nursery. — This contains more than five thousand trees, shrubs and vines, in various stages of growth, where the different methods of propagation by cuttings, layers, budding, grafting, pruning and training are practically taught to the students.

Garden. — All kinds of garden and farm-garden crops are grown in this department, furnishing ample illustration of the treatment of market-garden crops. The income from the sales of trees, plants, flowers, fruit and vegetables aids materially in the support of the department, and furnishes illustrations of the methods of business, with which all students are expected to become familiar.

Forestry. — Many kinds of trees suitable for forest planting are grown in the nursery, and plantations have been made upon the college grounds and upon private estates in the vicinity, affording good examples of this most important subject. A large forest grove is connected with this department, where the methods of pruning trees and the management and preservation of forests can be illustrated. In the museum and lecture room are collections of native woods, showing their natural condition and peculiarities; and there have been lately added the prepared wood sections of R. B. Hough, mounted on cards for class-room illustration.

Ornamental trees, shrubs and flowering plants are grouped about the grounds in such a way as to afford as much instruction as possible in the art of landscape gardening. All these, as well as the varieties of large and small fruits, are marked with conspicuous labels, giving their common and Latin names, for the benefit of the students and the public.

Tool House. — A tool house, thirty by eighty feet, has been constructed, containing a general store-room for keeping small tools; a repair shop with forge, anvil and work bench; and a carpenter shop equipped with a large Sloyd bench and full set of tools. Under one-half of this building is a cellar for storing fruit and vegetables. In the loft is a chamber, thirty by eighty feet, for keeping hot-bed sashes, shutters, mats, berry crates, baskets and other materials when not in use.

Connected with the stable is a cold-storage room, with an ice chamber over it, for preserving fruit, while the main cellar underneath the stable is devoted to the keeping of vegetables.

All the low land south of the greenhouses has been thoroughly underdrained and put into condition for the production of any garden or small fruit crop.

Zoölogical Department.

Zoölogical Lecture Room. — The room in south college is well adapted for lecture and recitation purposes, and is supplied with a series of zoölogical charts prepared to order, also a set of Leuckart's charts, disarticulated skeletons and other apparatus for illustration.

Zoölogical Museum. — This is in immediate connection with the lecture room, and contains the Massachusetts State collection, which comprises a large number of mounted mammals and birds, together with a series of birds' nests and eggs, a collection of alcoholic specimens of fishes, reptiles and amphibians, and a collection of shells and other invertebrates.

There is also on exhibition in the museum a collection of skeletons of our domestic and other animals, and mounted specimens purchased from Prof. H. A. Ward; a series of glass models of jelly fishes, worms, etc., made by Leopold Blaschka in Dresden; a valuable collection of corals and sponges from Nassau, N. P., collected and presented by Prof. H. T. Fernald; a fine collection of corals, presented by the Museum of Comparative Zoölogy in Cambridge; a collection of alcoholic specimens of invertebrates from the coast of New England, presented by the National Museum at Washington; a large and rapidly growing collection of insects of all orders; and a large series of clastic models of various animals, manufactured in the Auzoux laboratory in Paris.

It is the purpose of those in charge to render the museum as valuable to the student as possible; and with this end in view the entire collection has been rearranged so as to present a systematic view of the entire animal kingdom, with special regard to the fauna of Massachusetts. In the furtherance of this idea a special case has been prepared, in which are shown typical animals in such a way as to give a brief synopsis of the entire animal kingdom, forming a sort of index to the museum as a whole. In order to render our collection complete, particularly with reference to Massachusetts forms, we would gratefully receive donations of any sort, either alcoholic or otherwise preserved, especially among the worms, fishes, amphibians or reptiles. Specimens should be sent care of Prof. R. S. Lull. The museum is now open to the public from three to four P.M. every day except Sunday.

Zoölogical Laboratory. — A large room in the laboratory building has been fitted up for a zoölogical laboratory, with tables, sink, gas, etc., and is supplied with a reference library, microscopes, chemical and other necessary apparatus for work. This laboratory

with its equipment is undoubtedly the most valuable appliance for instruction in the department of zoölogy.

Entomological Laboratory. — An entomological laboratory was built adjoining the insectary the past summer, and completed ready for use at the beginning of the fall term. It is a two-story building, thirty-two by thirty-six feet on the ground, with a laboratory, lecture room, office, hall, apparatus and re-agent rooms on the first floor, and two private laboratories for advanced work, photographing room, with a dark room adjoining, janitor's room and hall on the second floor, while the large attic furnishes ample store room. This building, together with the insectary and greenhouse connected with it, are heated with a hot-water system, so arranged that any part may be shut off, and the remaining rooms heated when desired. Plans of this building were published in the report for 1895, on pages 14 and 15.

The laboratory occupies the whole northern and eastern portion of the first floor, which is well supported by brick piers, to prevent, as far as possible, any jar that would interfere with the microscopical and other delicate work that may be going on. The room is furnished with tables built especially for the kind of work to be done, and equipped with all the apparatus necessary for the needs of the student. A door from the office opens into the library of the insectary, in which are the leading works on economic entomology and a very complete card-catalogue of the literature of North American insects.

Veterinary Department.

This department is well equipped with the apparatus necessary to illustrate the subject in the class-room.

It consists of an improved Auzoux model of the horse, imported from Paris, constructed so as to separate and show in detail the shape, size, structure and relations of the different parts of the body; two *papier-maché* models of the hind legs of the horse, showing diseases of the soft tissues, — wind-galls, bogs, spavins, etc., also the diseases of the bone tissues, — splints, spavins and ringbones; two models of the foot, one according to Bracy Clark's description, the other showing the Charlier method of shoeing and the general anatomy of the foot; a full-sized model of the bones of the hind leg, giving shape, size and position of each individual bone; thirty-one full-sized models of the jaws and teeth of the horse and fourteen of the ox, showing the changes which take place in these organs as the animals advance in age.

There is an articulated skeleton of the famous stallion, Blackhawk, a disarticulated one of a thoroughbred mare, besides one

each of the cow, sheep, pig and dog; two prepared dissections of the fore and hind legs of the horse, showing position and relation of the soft tissues to the bones; a *papier-maché* model of the uterus of the mare and of the pig; a gravid uterus of the cow; a wax model of the uterus, placenta and fœtus of the sheep, showing the position of the fœtus and the attachment of the placenta to the walls of the uterus.

In addition to the above there is a growing collection of pathological specimens of both the soft and osseous tissues, and many parasites common to the domestic animals. A collection of charts and diagrams especially prepared for the college is used in connection with lectures upon the subject of anatomy, parturition and conformation of animals.

Through the kindness of Mr. Henry Adams of Amherst the department has received a large sample collection of the various drugs used in the treatment of the diseases of the domestic animals.

For the benefit of the students, sick or diseased animals are frequently shown them, and operations performed in connection with the class-room work. For the use of the instructor of this department a laboratory has been provided in the old chapel building. It has been equipped with the apparatus necessary for the study of histology, pathology and bacteriology, consisting in part of an improved Zeiss microscope with a one-eighteenth inch objective, together with the lower powers; a Lautenschlager's incubator and hot-air sterilizer; an Arnold's steam sterilizer and a Bausch and Lomb improved laboratory microtome. This apparatus is used for the preparation of material for the class-room and for general investigation.

Mathematical Department.

In view of the fact that the course of study pursued in the mathematical department has been considerably modified within the past year, it may be proper to explain, in some detail, the course as outlined at present.

At first glance it might appear that mathematics would play a very small part in the curriculum of an agricultural college, and, while it is true that its chief object is of a supplementary nature, it is equally true that, entirely aside from its value as a means of mental discipline, mathematics has a well-defined and practical object to accomplish. In this day of scientific experiment, observation and research on the farm, the advantages of a thorough knowledge of the more elementary branches of mathematics, general physics and engineering must be more than ever apparent;

and it is to meet the needs of the agricultural college student in these lines that the work in the mathematical department has been planned.

The mathematics of the freshman, sophomore and junior years are required, those of the senior year elective.

A glance at the schedule of studies will show the sequence of subjects: book-keeping, algebra, geometry and mechanical drawing in the freshman year; trigonometry, mechanical drawing and plane surveying — the latter embracing lectures and field work in elementary engineering, the use of instruments, computation of areas, levelling, etc. — in the sophomore year; general physics — including mechanics, electricity, sound, light and heat — and descriptive geometry or advanced mechanical drawing in the junior year; and, finally, two electives in the senior year, — mathematics and engineering respectively.*

The mathematical option includes the following subjects: fall term, plane analytic geometry, embracing a study of the equations and properties of the point, line and circle, and of the parabola, ellipse and hyperbola; winter term, differential calculus; and summer term, integral calculus.

The senior engineering option is designed to give to the student the necessary engineering training to enable him to take up and apply, on the lines of landscape engineering and the development of property, his knowledge of agriculture, forestry, botany and horticulture. It embraces a course of lectures, recitations and field work on the following subjects: topography, railroad curves, earth work, construction and maintenance of roads, water works and sewerage systems, etc.

It is believed that the engineering elective will equip the student to enter a comparatively new field, that of landscape engineering, which is coming more and more prominently before the public attention; for, with the increasing consideration which is being paid to the public health and the development and beautifying of our towns and cities, come fresh needs and opportunities.

Chemical Department.

Instruction in general, agricultural and analytical chemistry and mineralogy is given in the laboratory building. Thirteen commodious rooms, well lighted and ventilated and properly fitted, are occupied by the chemical department.

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* While these two electives are entirely distinct, the student electing engineering is strongly advised to elect mathematics also.

The lecture room, on the second floor, has ample seating capacity for seventy students. Immediately adjoining it are four smaller rooms, which serve for storing apparatus and preparing material for the lecture table.

The laboratory for beginners is a capacious room on the first floor. It is furnished with forty working tables. Each table is provided with sets of wet and dry re-agents, a fume chamber, water, gas, drawer and locker, and apparatus sufficient to render the student independent of carelessness or accident on the part of others working near by; thus equipped, each worker has the opportunity, under the direction of an instructor, of repeating the processes which he has previously studied in the lecture room, and of carrying out at will any tests which his own observation may suggest.

A systematic study of the properties of elementary matter is here taken up, then the study of the simpler combinations of the elements and their artificial preparation; then follows qualitative analysis of salts, minerals, soils, fertilizers, animal and vegetable products.

The laboratory for advanced students has been fitted up in the room previously known as the chapel. Here tables for thirty workers, with adequate apparatus, have been arranged. This is for instruction in the chemistry of various manufacturing industries, especially those of agricultural interest, as the production of sugar, starch fibres and dairy products; the preparation of plant and animal foods, their digestion, assimilation and economic use; the official analysis of fertilizers, fodders and foods; the analysis of soils and waters, of milk, urine and other animal and vegetable products.

The balance room has four balances and improved apparatus for determining densities of solids, liquids and gases.

Apparatus and Collections. — Large purchases of apparatus have recently been made. Deficiencies caused by the wear and breakage of several years have been supplied and the original outfit increased. The various rooms are furnished with an extensive collection of industrial charts, including Lenoir & Foster's series and those of Drs. Julius and George Schroeder. The apparatus includes balances, a microscope, spectroscope, polariscope, photometer, barometer and numerous models and sets of apparatus. A valuable and growing collection of specimens and samples, fitted to illustrate different subjects taught, is also provided. This includes rocks, minerals, soils, raw and manufactured fertilizers, foods, including milling products, fibres and other vegetable and animal products and artificial preparations of mineral and organic

compounds. Series of preparations are used for illustrating the various stages of various manufactures from raw materials to finished products.

Library.

This now numbers 17,080 volumes, having been increased during the year, by gift and purchase, 1,280 volumes. It is placed in the lower hall of the chapel-library building, and is made available to the general student for reference or investigation. It is especially valuable as a library of reference, and no pains will be spared to make it complete in the departments of agriculture, horticulture, botany and the natural sciences. It is open a portion of each day for consultation, and an hour every evening for the drawing of books.

PRIZES.

Burnham Rhetorical Prizes.

These prizes are awarded for excellence in declamation, and are open to competition, under certain restrictions, to members of the sophomore and freshman classes.

Flint Prizes.

Mr. Charles L. Flint of the class of 1881 has established two prizes, one of thirty dollars and another of twenty dollars, to be awarded, at an appointed time during commencement week, to the two members of the junior class who may produce the best orations. Excellence in both composition and delivery is considered in making the award.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first and second prize, to be called the Grinnell agricultural prizes, in honor of George B. Grinnell, Esq., of New York. These two prizes are to be paid in cash to those two members of the graduating class who may pass the best written and oral examination in theoretical and practical agriculture.

Hills Botanical Prizes.

For the best herbarium collected by a member of the class of 1896 fifteen dollars is offered, and for the second best a prize of ten dollars; also a prize of five dollars for the best collection of dried plants from the college farm.

The prizes in 1895 were awarded as follows: —

Burnham Rhetorical Prizes: John A. Emrich (1897), first; George D. Leavens (1897), second; Willis S. Fisher (1898), first; Randall D. Warden (1898), second.

Flint Oratorical Prizes: Frank E. DeLuce (1896), first; Frank L. Clapp (1896), second.

Grinnell Agricultural Prizes: Wright A. Root (1895), first; Clarence B. Lane (1895), second; George A. Billings (1895), third.

Hills Botanical Prizes: Harold L. Frost (1895), first; Frederick C. Tobey (1895), second.

Collection of Woods: Harold L. Frost (1895).

Collection of Dried Plants: Harold L. Frost (1895).

Military Prize: Gold Medal, presented by I. C. Greene, '94, Charles A. Norton (1897).

RELIGIOUS SERVICES.

Students are required to attend prayers every week-day at 8 A.M., and public worship in the chapel every Sunday at 10.30 A.M. Further opportunities for moral and religious culture are afforded by a Bible class taught by one of the professors during the hour preceding the Sunday morning service and by religious meetings held on Sunday afternoon and during the week, under the auspices of the College Young Men's Christian Association.

LOCATION.

Amherst is on the New London Northern Railroad, connecting at Palmer with the Boston & Albany Railroad, and at Miller's Falls with the Fitchburg Railroad. It is also on the Central Massachusetts Railroad, connecting at Northampton with the Connecticut River Railroad and with the New Haven & Northampton Railroad.

The college buildings are on a healthful site, commanding one of the finest views in New England. The large farm of three hundred and eighty-three acres, with its varied surface and native forests, gives the student the freedom and quiet of a country home.

APPENDIX.

The Crambidæ of North America.

C. H. Fernald, A.M., Ph.D.

January, 1896.

THE CRAMBIDÆ OF NORTH AMERICA.

The insects included in the family *Crambidæ* are, so far as known, injurious to the grasses (*Gramineæ*), some living in tubular habitations which they construct near the roots, others boring into the stems of the plants on which they feed, while a few occasionally feed on plants of other families.

Distribution.

The species of this family are distributed very widely over the globe, but apparently are most numerous in the temperate zones. They are well represented in Europe and North America, and even Australia and New Zealand have a comparatively large number of species.

Injuries.

These insects feed at the roots of the grasses, and are therefore often overlooked, except where they are so abundant as to seriously injure the crops. They undoubtedly destroy a large amount of grass without being discovered, the injury being attributed to some other cause. Prof. F. M. Webster, entomologist to the Ohio Agricultural Experiment Station, wrote me, Dec. 12, 1895, that the larvæ of some species of *Crambus*, probably *trisectus* and *laqueatellus*, during May of that year were the most abundant and destructive that he had ever known them to be in the West; hundreds of acres of both corn and oats, which had been planted on spring-ploughed meadow or pasture lands, were as completely swept out of existence as if burned over, and the damage done by these insects would probably amount to several hundred thousand dollars. Professor Webster also

wrote that, a few years ago, the larvæ of *Crambus vulgivagellus* ravaged the corn fields of Ashtabula County, Ohio.

In 1881, the larvæ of *Crambus vulgivagellus* devastated the fields of several counties in northern New York, and were very abundant in many other places during that year. In 1892, the larvæ of *Crambus caliginosellus* were reported as doing great damage to corn in Delaware and Maryland, and it is a common thing to receive these moths from the farmers in various parts of the country, stating that they are more or less abundant.

Natural Enemies.

Professor Lintner bred a Hymenopterous and a Dipterous parasite from these insects, and also found the predaceous beetle, *Calosoma calidum* (Fab.), destroying them, as he believed. Professor Riley also bred two different Hymenopterous parasites from the larvæ of *C. laqueatellus.* Insectivorous birds are known to feed freely upon these moths. Professor Webster states, on the authority of J. N. Latta of Haw Patch, Ind., that the moths of *Crambus laqueatellus* were destroyed in great numbers by the wood pewee (*Contopus virens*), and I have myself observed barn swallows feeding on different species of *Crambus* in abundance in Maine. When walking through the grass, at my home on Mt. Desert, the *Crambids* were "flushed," and several swallows invariably attended us, snapping up the moths as they flew. Whenever we stopped the swallows would leave; and as soon as we started, they would return to catch the moths, often flying within a few feet of us. These observations were made during several years, and led me to conclude that farmers would do well to afford every possible encouragement to these birds to nest in their barns, for they do a vast amount of good in destroying injurious insects while on the wing.

History.

The species of this family were placed by Linnæus, in all his writings, under his genus *Tinea.* The authors of the "Systematisches Verzeichniss der Schmetterlinge der Wienergegend," published in 1776, placed them under the *Tineæ*,

in the division of *Tineæ Directipalpes.* Hübner, in his "Sammlung europäischer Schmetterlinge," figures the European species under the genus *Tinea.* A part of the plates on which these species are represented were published in 1796. Fabricius, in the supplement to his "Entomologia Systematica," p. 464, published Feb. 10, 1798, established the genus *Crambus* with sixty-two species under it, some of which do not belong to this genus and they have since been removed to other genera. Fabricius did not mention any species as the type of the genus. In Vol. III., part II., of this work, published in 1794, on p. 238, he described the species *saccharalis;* and, so far as I can learn, this was the first species of the family published from this country. Latreille, in his "Histoire Naturelle des Crustaces et Insects," Vol. XIV., p. 247, 1805, adopts the generic name *Crambus*, and places under it *carnella* L., *pinellus* L., *culmellus* L. and *pascuellus* L. The last three are still retained in the genus *Crambus.*

In 1811, Haworth published part III. of his "Lepidoptera Britannica," in which he established the genus *Palparia* for the species usually placed under *Crambus.* He had previously, in part II. of the same work, used the genus *Crambus*, but, strange to say, he had none of the species now regarded as *Crambids* under it. Leach, in the article "Entomology" in the "New Edinburgh Encyclopædia," published in 1815, adopted the generic name *Crambus*, with *pineti*, *pascuorum* and *pratorum* under it, and placed it as the second genus in his family *Tineida.* In 1817, Zincken, in Germar's "Magazin der Entomologie," Vol. II., published his monograph of the genus *Chilo*, with *phragmitellus* Hüb. as the first species under it, and this has been taken as the type of *Chilo.* Zincken included in his genus most of the species now retained under *Crambus.* In Vol. III., p. 114, 1818, Zincken described *C. leachellus*, the habitat of which was unknown, but it has since proved to be a well-known North American species; and in Vol. IV., p. 247, 1821, *C. sordidellus*, *satrapellus*, *præfectellus*, *decorellus*, *plejadellus*, *teterrellus* and *incertellus* from South Carolina, and *C. haytiellus* from the Island of San Domingo, but I have received this last species both from San Domingo and

Texas. Hübner, in his "Verzeichniss bekannter Schmetterlinge," did not adopt the generic name *Crambus*, but placed the species of the *Crambidæ* under several genera, as follows: *Argyroteuchia*, with ten species; *Eucarphia*, with *radiellus*, *fulgidellus* and *vinetella* under it. (The first two belong to the genus *Crambus*, but the last belongs to the *Phycitinæ*, and has been left as the type of *Eucarphia*.) *Catoptria*, with six species; *Agriphila*, with five species; *Pediasia*, with seven species; *Topeutis*, with ten species; *Eromene*, with one species, *bella*; *Chrysoteuchia*, with two species; *Thisanotia*, with three species; and *Exoria*, with three species. This part of Hübner's "Verzeichniss" was published not earlier than 1822. In 1825, Curtis, in his "British Entomology," Vol. III., p. 109, adopted *pascuellus* L. as the type of the genus *Crambus*. I am not aware that any one, previous to this time, specified any one of the species as the type, and therefore, in accordance with the rules of zoölogical nomenclature, this species may be regarded as such.

Stephens, in his "Illustrations of British Entomology, Haustellata," Vol. IV., p. 317, 1834, adopted the generic name *Crambus*, with thirty-eight species, but placed it in his family Tineidæ. In 1836, Duponchel published the tenth volume of "Histoire Naturelle des Lepidopteres," in which he adopted the genus *Chilo*, with *phragmitellus* under it, and *Crambus*, with many species that properly belong there, and some others that have since been placed elsewhere. In 1840, Zetterstedt, in his "Insecta Lapponica," adopted the genus *Chilo* for the species now usually placed in the *Crambidæ*, and placed it in his family *Tineariæ*, thus following the plan of Zincken.

In Vol. IX., part II., of "Die Schmetterlinge von Europa," published in 1832, Treitschke adopted the genus *Chilo*, and placed *gigantellus* Fab., with forty-three other species, under it. In 1849, Herrich-Schäffer published the fourth volume of his "Schmetterlinge von Europa," in which he established the group *Crambides*, in which he placed all the *Pyralids*, including the genera *Chilo*, *Crambus* and *Ancylolomia*.

In 1858, Christoph, in the "Stett. Ent. Zeit.," Vol. XIX., p. 313, described two species of *Crambus* from Labrador.

In 1860, Clemens described twelve species under the genus *Crambus*, in the "Proceedings of the Academy of Natural Sciences of Philadelphia," one of which, *auratellus*, belongs in the genus *Argyria*. In the same paper he published three species and placed them under the genus *Chilo*, but they did not belong there, and have been more correctly placed under the genus *Schœnobius*, which is not now regarded as belonging to the *Crambidœ*. In 1863, Walker, in his "Cat. Lep. Het.," part XXXVII., adopted the family name *Crambidœ*, with *Chilo*, *Crambus* and several other genera under it. Several North American species were described for the first time in this work, and some others were re-described. In a few cases the descriptions were made from very poor specimens, and it is not only impossible to determine the insects from his description, but very difficult to decide what they are from the types. In 1863, Zeller published a valuable work entitled "Chilonidarum et Crambidarum genera et species," in which he dealt with all the described species, and published many new ones from North America, as well as elsewhere. This work, although appearing in the same year as Walker's, was not published till July, while Walker's catalogue was published in April.

In 1866, Packard described two species of *Crambus* from Labrador, in the "Proceedings of the Boston Society of Natural History." Grote published several species, with a list, in the "Canadian Entomologist," in 1880; and Hulst described several species in the "Transactions of the American Entomological Society," in 1886.

In 1894, Felt published a paper "On Certain Grass-eating Insects," which deserves more than a passing notice. In this paper, for the first time, a special study was made of the early stages of a large number of our species, including their habitations, etc. There is still much to be done in this direction, and it is sincerely to be hoped that the work, so well begun by Mr. Felt, may be continued till we have a complete history of all our species of this family. I should mention, in this connection, the work done by Forbes on the early stages of *zeellus*, by Howard on *saccharalis*, by Miss Murtfeldt on *teterrellus* and by Scudder on *hortuellus*.

External Anatomy.

The following studies were made on *Crambus laqueatellus* with occasional references to the other species. The head (Plate A, figs. 1 and 2) is of moderate size, and connected with the thorax by a small neck. The compound eyes (Plate A, figs. 1–4, *e*) are large and hemispherical, varying somewhat in outline in the different species. The ocelli (Plate A, figs. 1–3, *o*), situated behind and near the base of the antennæ, are present in most of these insects. The antennæ (Plate B, figs. 15–17) have from fifty to fifty-five segments in *C. laqueatellus*, the basal segment being much larger than the others; the first two are covered with scales and the others with two scale clusters each, on the upper side, while fine hairs are scattered over the remaining surface (Plate A, fig. 9, and Plate B, figs. 15–17). All except a few of the basal joints have several sense pits on each side (generally four in the male and three in the female). These sense pits are circular in outline, guarded by a row of hairs which arise obliquely from the edge, and are located somewhat irregularly on the joints. Under a high magnifying power the antennal segments appear to have a reticulated surface (Plate A, fig. 10).

The epicranium is separated from the clypeus by a well-marked transverse suture just in front of the base of the antennæ. The clypeus is large and convex (Plate A, fig. 3); in some species it is more or less swollen in the middle, while in others it is produced in the form of a cone. The cheeks occupy the lower and lateral portions of the face. The small, somewhat triangular labrum is in front of the clypeus and over the base of the tongue. The mandibles are rudimentary, and armed with bristles which extend inward and rest on the base of the tongue. The maxillæ are developed into a sucking tube, which is called the proboscis or tongue. This organ varies in length, to some extent, in the different species, and is covered with scales at the basal part. When not in use it is coiled up, like a watch-spring, between the labial palpi, and concealed by them. The labial palpi have three segments, extended horizontally forward and thickly covered with scales. They vary greatly in length in the different species (Plate A, figs. 1, 2 and 3;

Plate C, figs. 1, 4, 10, 12 and 16). The maxillary palpi have three segments extending forward nearly horizontally and resting on the base of the labial palpi. They are densely scaled, and at the outer end the scales form a triangle.

Curtis figures the structural characters of what he calls *Tinea paleella* Hüb. on Plate 109 of his "British Entomology," together with *Crambus radiellus* Hüb., and represents the maxillary palpus of *paleella* with four segments arising from the side of the tongue. Felt, in his excellent work on *Crambus*, gives a figure of the maxillary palpus of *C. agitatellus*, with four joints.

The above studies were made on dry specimens, and a fourth segment could not be found. Whether it is visible in fresh specimens, I am not able to say. The maxillary palpi in dry specimens of *C. laqueatellus* certainly do not arise from the side of the base of the tongue, unless, in drying, the tissues about the mouth-parts have so shrunken as to draw them far out on the sides, as shown on Plate A, fig. 3. Mr. Felt does not indicate the origin of the maxillary palpi in his work.

The prothorax is very small, and the upper side is divided into two parts. Scudder has given the name of prothoracic lobes to similar structures in the butterflies. The mesoscuta are large, and extend far back on each side of the large mesoscutellum. The metascuta are much smaller than the mesoscuta, and are followed behind by the metascutellum. On the forward edge of the metascutum there is an area (Plate A, figs. 1 and 2) without scales or hairs, but covered with minute spines directed forward. This corresponds to a similar spiny area on the under side of the fore wing. The abdomen consists of eight segments. The genitalia of the male are often retracted to such an extent that they are not visible beyond the end of the eighth segment. No figures of these organs are given here, as Mr. Felt has already given most excellent figures of the genitalia of twenty-six different species of *Crambus*.

The legs (Plate A, figs. 5, 7 and 8) are of medium length and size, and consist of the coxa, which is comparatively long and stout; the trochanter, which is of medium size; the femur, which is of medium size and length, the middle

femur being the longest; the tibia, which is rather slim; and the tarsus, consisting of five segments, the last of which terminates in a pair of claws. There is a tibial epiphysis near the end of the fore tibia (Plate A, figs. 5 and 6), which is armed with bristles on the inner side. The tibia of the middle leg has a pair of spurs at the end, the outer of which is about two-thirds as long as the inner, and the hind tibia has a pair at the end and a similar pair at the outer third.

The fore wings are long and narrow in most of the species, while the hind wings are broad. I have adopted in this work the old system of numbering the veins, at the risk of being considered behind the times, for the reason that, notwithstanding we have recently been given several systems or modifications of nomenclature by authors in whom I have great confidence, I must confess that as yet I am undecided which one should be taken. The old system of venation of Herrich-Schäffer is shown in the wings of *Crambus pascuellus* (Plate B, figs. 1 and 2). The cell in the fore wings is closed, but in the hind wings it is closed in some species and open in others. The frenulum of the hind wing is single in both sexes, though there is an indication at the base that it is composed of several bristles fused together (Plate B, fig. 13, male, fig. 14, female).

The veins terminate at the margins of the wings in a rather indefinite way, but at a short distance from the end there are two circular spots on each vein, with short irregular lines radiating from them (Plate A, fig. 11). There is a row of peculiar spines around the outer margin, which are placed at equal distances from each other and arise very near the edge of the wing (Plate A, fig. 11, *s*). Near the base of the hind margin of the fore wing, on the under side, is a small, oval, spiny area (Plate B, fig. 11). There are no scales on this area, but it is covered with short, sharp spines, which point toward the outer end of the wing. A portion of this area, with a few of the adjacent scales, is shown on Plate B, fig. 12. This area is so placed that when the wings are closed it rests upon the similar area on the side of the metascutum, already mentioned, and the spines on the two areas then point in opposite directions. My assistant, Mr. R. A. Cooley, a most careful and pains-

taking student of entomology, first discovered these spiny areas on the wings of the gypsy moth, and has since found them in a large number of our moths and also on the *Trichoptera*. In the butterflies, however, Mr. Cooley finds the scales modified in this place to such an extent that they are intermediate between spines and scales; but in the *Pterophoridæ* there are no spiny areas. So far as he has carried his studies, it would seem that they are present in those insects which close the wings in such a manner that the under side of the basal part of the hind margin of the fore wing rests on the side of the thorax; but in those insects which do not hold the wings in this manner they do not occur, or, if present, are in a modified form. Mr. Cooley will soon publish the result of his studies.

After Mr. Cooley had found the spiny area in the fore wing of the gypsy moth, I learned that Donitz had previously discovered a similar area in the fore wing of *Dionychopus niveus* Men. of Siberia; but he claims to have found its counterpart on the hind wing, and considers it a musical apparatus. I do not know how *Dionychopus* holds its wings when at rest, and cannot express any opinion as to the accuracy of the observations and conclusions of Donitz; but I am inclined to think that the insects observed by Mr. Cooley use this apparatus for an entirely different purpose.

Family CRAMBIDÆ.

The moths included in this family are medium or rather small in size, generally of light colors. Brown, yellow and white prevail, and many of them have metallic markings on the fore wings, which are comparatively long, and in some cases narrow. These are rolled around the body when the insect is at rest, and conceal the large hind wings, which are folded beneath.

The ocelli are present in most of the species. The labial palpi are porrect, nearly straight and often long, sometimes as long as the head and thorax; the maxillary palpi are well developed and strongly triangular. The fore wings have veins 4 and 5 arising near each other, or sometimes from a stalk; 8 and 9 stalked or sometimes fused, forming a single

vein; 7 sometimes arises from the stalk of 8 and 9; 11 from beyond the middle of the cell. Hind wings, on the upper side, with a row of long hairs on the hind margin of the basal part of the cell; veins 4 and 5 stalked, or united throughout as one vein; 7 arises from 6, near its origin, anastomosing with 8.

These insects usually fly near sunset, but may be "flushed" at any time during the day. The eggs are more or less melon-shaped, ribbed and reticulated, or smooth. Larva smooth, with few hairs, feeding in silk-lined galleries on the grass family, or boring in stems. Pupa formed in a cocoon within the galleries.

Synopsis of the Genera.

1.	Outer margin of fore wing with one indentation,	2.
	Outer margin of fore wing without indentations,	4.
2.	Hind wings with eight veins,	*Eugrotea.*
	Hind wings with seven veins,	3.
3.	Fore wings more than three times as long as wide,	*Pseudoschœnobius.*
	Fore wings less than three times as long as wide,	*Prionapteryx.*
4.	Hind wings with seven veins,	*Uinta.*
	Hind wings with eight veins,	5.
5.	Fore wings with veins 7, 8 and 9 arising from one stalk,	6.
	Fore wings with vein 7 separate from the stalk of 8 and 9,	7.
6.	Antennæ of the male pectinate,	*Thaumatopsis.*
	Antennæ of the male not pectinate,	*Crambus.*
7.	Ocelli present,	8.
	Ocelli absent,	*Diatræa.*
8.	Fore wings three times as long as wide,	*Euchromius.*
	Fore wings not more than twice as long as wide,	9.
9.	Fore wings white, with yellow markings,	*Argyria.*
	Fore wings yellow or brown,	*Chilo.*

Uinta Hulst.

Head medium; front smooth and vertical; eyes large and hemispherical; ocelli present; antennæ coarsely ciliated, and toothed near the base; labial palpi porrect, about three times as long as the head, and coarsely scaled; maxillary palpi about as long as the head, quite bushy and triangular; tongue rudi-

mentary, scaled at the base. Fore wings with ten veins; 4 and 5 coalesce so as to appear as one; 7 arises from the stem of 8 and 9; 10 and 11 coalesce, forming one vein. Hind wings with a distinct pecten of hairs on the basal part of the median vein on the upper side; seven veins; 4 and 5 coalesce, forming but one vein.

This genus was established by Rev. Geo. D. Hulst in "Entomologica Americana," Vol. IV., p. 116, 1888.

Uinta oreadella Hulst. (Plate VI., fig. 14.)

Expanse of wings, 15 mm. (about three-fifths of an inch). Head and palpi very dark gray; thorax blackish gray. Fore wings dark fuscous, darker at the base; basal line wanting; outer line broad, dark brown; terminal line also dark brown, and a dark-brown dot occurs near the middle of the wing. Hind wings fuscous.

Only a single example of this species is at present known, and that is in the collection of the Rev. G. D. Hulst, who received it from Colorado, and published the description of it in "Entomologica Americana," Vol. IV., p. 116, 1888. I am under obligations to Mr. Hulst for the loan of this and other insects from which to make the drawings that appear in this work. Nothing is known of the early stages and habits of this rare insect.

PRIONAPTERYX Stephens.

Head medium, face slightly cone-shaped; eyes large, nearly hemispherical; ocelli absent; antennæ serrate in the male, simple in the female, nearly two-thirds as long as the costa; labial palpi porrect, about twice as long as the head and coarsely scaled at the end; maxillary palpi triangular, half as long as the labial palpi, and resting on them; tongue well developed; thorax and abdomen smooth. Fore wings with twelve veins, 6 and 7 from one point or stalked, 11 and 12 approach very near or join near the middle of 11, after which they run separately to the costa; outer margin notched near the end of vein 5. This genus was established by Stephens for a mutilated example of an insect which he described under the name of *nebulifera*, and of which he says: "Of this sin-

gularly remarkable insect I have seen only my own specimen, which I obtained from the collection of Mr. Haworth, who appears to have procured it from that of Mr. Francillon; I know not its locality." The type is in the Stephens collection in the British Museum, and shows very plainly the mutilation in the costa of the fore wings, which he describes as "three or four deep serratures towards the apex." It is our well-known North American species by that name, and the type was undoubtedly from this country.

PRIONAPTERYX NEBULIFERA. (Plate VI., fig. 1.)

Prionapteryx nebulifera Steph., Ill. Br. Ent. Haust., Vol. IV., p. 317 (1834).
Prionapteryx nebulifera Wood, Ind. Ent., p. 214, Plate XLVII., fig. 1484 (1854).
Prionopteryx nebulifera Zell., Chil. et Cram., p. 18 (1863).

Expanse of wings, 22–31 mm. Palpi, head and thorax ashy brown. Fore wings brown, with a short oblique white streak on the middle of the costa and two broader spots before the apex; an irregular quadrate white spot before the middle of the wing, extending from the hind margin across the cell; two parallel white stripes within the outer margin, within which is a large white spot with several dashes of brown upon it. Fringes cream-white, marked with two or three streaks of brown below the apex. Hind wings pale fuscous, whitish at base.

Habitat. — Texas. Early stages and food plant unknown.

PRIONAPTERYX ACHATINA. (Plate VI., figs. 2 and 3.)

Prionopteryx achatina Zell., Chil. et Cram., p. 13 (1863).
Crambus delectalis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 165 (1886).

Expanse of wings, 22–25 mm. Palpi, head and thorax sordid white, dusted over with cinnamon-brown scales. Fore wings white, dusted over with cinnamon-brown scales, except on the two cross-lines; the inner one near the middle of the wing with two outward angles, the outer one somewhat arcuate. The brown scales are more numerous within

and on the outside of the outer line; those on the hind part are very much darker brown, forming an ill-defined dark spot, a similar spot between this and the base of the wing. The terminal portion of the wing white, with two dark-brown horizontal dashes and more or less light brown above the middle. Hind wings pale fuscous, paler basally.

Habitat. — Texas, Arizona. Early stages and food plant unknown.

I have carefully examined the types of Zeller and Hulst.

PRIONAPTERYX CUNEOLALIS. (Plate VI., fig. 4.)

Crambus cuneolalis Hulst, Tr. Am. Ent. Soc., Vol XIII., p. 166 (1886).

Expanse of wings, 19–22 mm. Palpi, head and thorax sordid white, dusted over with cinnamon-brown scales, darkest on the palpi. Fore wings white, dusted over with brown scales, but leaving cross-lines; the inner one, near the middle of the wing, edged outwardly with brown, has two angles; the outer one, angulate beyond the cell, and edged with brown on the inside. The terminal space white near the apex and also in the middle, which is crossed by four dark dashes. Fringe interlined, dark brown and white at the apex and fuscous behind. Hind wings pale fuscous, paler basally.

Habitat. — Texas. Early stages and food plant unknown.

PRIONAPTERYX INCERTELLA.

Chilo incertella Zinck., Germ. Mag., Vol. IV., p. 253 (1821).
Prionopteryx incertella Zell., Chil. et Cram., p. 14 (1863).
Prionopteryx incertella Robs., Ann. Lyc. N. H. of N. Y., Vol. IX., p. 311 (1869).
Prionopteryx olivella Grote, Bull. U. S. Geo. Sur., Vol. VI., p. 274 (1881).

Expanse of wings, 19–25 mm. Palpi, head, thorax and fore wings olive fuscous, the olive tint more apparent in fresh specimens. The fore wings have a pale shade along the submedian fold from the base outwardly; a pale-yellow or whitish mark on the middle of the costa, and a larger one beyond it at the outer third; an outwardly curved line from

the costa to near the middle of the outer margin. Subterminal line pale, bent outwardly above the median fold and running inwardly below it to the hind margin, just within the anal angle, dentate through the latter part of its course; a fuscous blotch on the hind margin at the basal fourth, and another at the middle, which borders outwardly a very fine angulated line connecting with the first costal mark. The terminal line fine, occurring only on the hind part of the outer border. Fringes pale at base, fuscous outwardly. Hind wings pale fuscous.

Habitat.—North Carolina, Georgia, Illinois. Early stages and food plant unknown.

I have carefully examined the types of Zeller and Grote.

EUGROTEA n. gen.

Head medium; face cone-shaped; eyes hemispherical; ocelli present; antennæ simple in the female, male not seen; labial palpi porrect, about three times as long as the head, coarsely haired; maxillary palpi triangularly scaled, about twice as long as the head; tongue well developed; thorax and abdomen smooth; legs of medium length and size; inner spurs one-third longer than the outer. Fore wings two and one-half times as long as wide, with twelve veins; 4 and 5 on a long stalk, 7, 8 and 9 from one stalk; the outer margin notched at the end of vein 4. Hind wings one and a half times as long as wide, with eight veins; 4 and 5 from a long stalk; cell closed.

I have named this genus in honor of my old friend, Prof. A. R. Grote, who years ago advised me to take up the study of the North American microlepidoptera, and has ever since taken a lively interest in my work.

Eugrotea dentella n. sp. (Plate VI., fig. 5.)

Expanse of wings, 25 mm. Head, thorax and palpi white, heavily sprinkled with dark-brown scales. Fore wings white, marked with dark brown (olivaceous in certain lights) on the basal half of the costa down to the cell; on the basal third of the hind margin, a more or less zigzag or dentate cross-stripe a little beyond the middle, a second irregular cross-stripe

between the last and the outer margin, one or two oblique stripes near the apex and the terminal line, are all brown. There are also more or less brown scales sprinkled over the white portions of the wing. In this respect there is a great deal of variation. Fringes pale at the base, fuscous outwardly. Hind wings pale fuscous, with finely interlined fringes.

Habitat. — Florida. Early stages and food plant unknown.

PSEUDOSCHŒNOBIUS n. gen.

Head medium; face cone-shaped; eyes hemispherical; ocelli present; antennæ (Plate B, fig. 16) finely toothed and ciliate, about two-thirds the length of the costa; labial palpi porrect, about three times the length of the head; maxillary palpi triangular, about as long as the head; tongue rudimentary; thorax smooth; legs long and slim, all the inner spurs twice as long as the outer; abdomen long and slim.

Fore wings (Plate C, fig. 8) three and a half times as long as wide; outer margin falcate and apex rounded; eleven veins, 4 and 5 from one point, 6 and 7 from a short stem, 8 and 9 from one stem; 11 arises from the outer third of the cell and runs into 12, fusing with it from the point of junction to the costa; 1 *a* is nearly half as long as the wing; 1 *b* is simple at the base. Hind wings (Plate C, fig. 9) triangular, not quite twice as long as wide; veins 4 and 5 coalesce, forming but one vein, 6 remote from 7; median vein above pectinated basally. This genus was first proposed in Smith's "List of the Lepidoptera," 1891, for *opalescalis*, a species described by Hulst, from Arizona, and placed under *Schœnobius;* but, as the structure of the insect gave it no abiding place in any genus already established, we have now characterized this new genus for it.

Pseudoschœnobius opalescalis. (Plate VI., fig. 13.)

Schœnobius opalescalis Hulst, Trans. Am. Ent. Soc Vol. XIII., p. 167 (1886).

Expanse of wings, 29 mm. Palpi dark fuscous, cinereous above; head and thorax cinereous, the tegulæ edged with white; abdomen fuscous, annulate with cinereous; fore wings cinereous, with white scales scattered profusely between the veins; fringe of the same color as the wings. Hind wings above and beneath light fuscous, somewhat opalescent. Under side of fore wings fuscous, paler towards the apex. Described from six examples in my collection, from Arizona; one in the collection of the National Museum, from the Argus Mountains, Cal.; and the type in the collection of Mr. Hulst.

CRAMBUS Fabricius.

Head medium; face rounded, more or less swollen or cone-shaped; eyes more or less hemispherical; ocelli present; antennæ about two-thirds as long as the costa, dentate or ciliate in the male (Plate B, fig. 17), simple in the female (Plate A, fig. 9); labial palpi very long, porrect; maxillary palpi moderately long, porrect, triangularly dilated with scales (Plate C, fig. 16); tongue well developed; thorax smooth; abdomen of the male with a small anal tuft.

Fore wings from two to three times as long as wide, with twelve veins; 4 and 5 sometimes from a stalk; 7, 8 and 9 from a common stalk; 11 bent more or less and sometimes connected with 12. Hind wings about one and one-half times as long as wide; veins 4 and 5 from one point or from a stalk.

This genus contains by far the largest number and the most common of our species. From the studies of Riley, Lintner, Forbes, Felt, Beckwith and Miss Murtfeldt, we know something of the early stages of a large number of our species.

Synopsis of the Species.

1.	Fore wings with ground color whitish, ...	2.
	Fore wings with ground color ochreous, brown or gray, .	6.
2.	Fore wings without markings or terminal dots, . .	*perlellus.*
	Fore wings with markings or terminal dots, ...	3.
3.	Fore wings with a longitudinal reddish stripe near the middle,	*girardellus.*
	Fore wings with a terminal and a subterminal row of black dots, ...	*turbatellus.*
	Without these characters, ...	4.
4.	Subterminal line slightly curved, ...	*elegans.*
	Subterminal line strongly angulated, ...	5.
5.	Median line widest on the hind margin, ...	*pusionellus.*
	Median line not reaching the hind margin, . . .	*albellus.*
6.	Fore wings with a white stripe from base to middle or beyond, ...	7.
	Fore wings without such stripe, ...	28.
7.	The median white stripe wide and crossed by two oblique bars, ...	8.
	The median white stripe not crossed by two oblique bars, .	9.
8.	The inner bar on the middle of the wing, . . .	*myellus.*
	The inner bar beyond the middle of the wing, .	*luctiferellus.*
9.	Median stripe extended to terminal line, but divided outwardly, ...	*dimidiatellus.*
	Median stripe extended undivided to terminal line,	*unistriatellus.*
	Median stripe not reaching terminal line, ...	10.
10.	Stripe divided into costal and subcostal stripes, . . .	11.
	Stripe not divided, ...	15.
11.	Hind wings pure white, ...	*multilineëllus.*
	Hind wings not pure white, ...	12.
12.	Apex of fore wing strongly acuminate, ...	*minimellus.*
	Apex of fore wing not strongly acuminate, ...	13.
13.	Terminal dots preceded by black lines, . . .	*laqueatellus.*
	Terminal dots not preceded by black lines, ...	14.
14.	Outer border notched on vein 6, ...	*dumetellus.*
	Outer border straight or nearly so, ...	*agitatellus.*
15.	Median stripe with a tooth near middle of costal edge,	*carpenterellus.*
	Median stripe without a costal tooth, ...	16.

16.	Hind margin of fore wings more or less white,	17.
	Hind margin of fore wings not marked with white,	19.
17.	Hind marginal streak entire,	*pascuellus.*
	Hind marginal streak interrupted,	18.
18.	Fore wings bright brown,	*dissectus.*
	Fore wings dark brown,	*labradoriensis.*
19.	Apex strongly acuminate; tooth of stripe long,	*satrapellus.*
	Apex not strongly acuminate; tooth not long,	20.
20.	Hind wings pure white,	21.
	Hind wings not pure white,	24.
21.	White stripe short and wide, with the tooth near the end,	*bidens.*
	White stripe with tooth small and near the middle,	22.
22.	Apex acuminate,	*hastiferellus.*
	Apex not acuminate; slightly emarginate,	23.
23.	White stripe wide, very near the costa,	*leachellus.*
	White stripe narrower; more remote from costa,	*præfectellus.*
24.	White stripe narrower than the costal border,	*argillaceëllus.*
	White stripe wider than the costal border,	25.
25.	White stripe more than two-thirds as long as the wing,	26.
	White stripe not more than two-thirds as long as the wing,	*alboclavellus.*
26.	Under side of cell marked with black,	*occidentalis.*
	Under side of cell not marked with black,	27.
27.	Fore wings ochreous cinereous,	*cypridalis.*
	Fore wings brown,	*hamellus.*
28.	Terminal line present above, with three or four dots below,	29.
	Terminal row of three or four dots below and none above,	30.
	Terminal row of seven dots,	31.
	Terminal line more or less indistinct,	44.
29.	Outer margin falcate,	*gausapalis.*
	Outer margin not falcate,	*hortuellus.*
30.	Fringes of fore wings cut with whitish,	*trisectus.*
	Fringes of fore wings not cut with whitish,	*laciniellus.*
31.	Veins in the middle of fore wing whitish,	32.
	Veins in the middle of fore wing not whitish,	33.
32.	Veins of hind portion light, edged with black scales,	*coloradellus.*
	Veins of hind portion light, but not edged with black scales,	*bollerellus.*
	Veins of hind portion not light,	*albilineëllus.*
33.	Fringes golden yellow,	34.
	Fringes not golden yellow,	37.

34.	Without median or subterminal lines,	*vulgivagellus.*
	With cross lines,	35.
35.	Terminal space a brighter yellow than rest of wing,	*decorellus.*
	Terminal space of the same shade as rest of wing,	36.
36.	Subterminal line narrow,	*ruricolellus.*
	Subterminal line broad,	*biothanatalis.*
37.	Several heavy brown stripes between the lines,	*hulstellus.*
	Without brown stripes between the cross lines,	38.
38.	Subterminal line finely dentate,	39.
	Subterminal line not dentate,	40.
39.	Bright yellow along the submedian fold,	*hemiochrellus.*
	Submedian fold not bright yellow,	*mutabilis.*
40.	Subterminal line very near the outer margin,	*attenuatus.*
	Subterminal line not very near the outer margin,	41.
41.	With white lines through the middle,	*haytiellus.*
	Without white lines through the middle,	42.
42.	Top of the head and thorax white,	*teterrellus.*
	Top of the head and thorax not white,	43.
43.	Fore wings reddish brown,	*anceps.*
	Fore wings grayish,	*undatus.*
44.	Dark brown with white median shade and subterminal line,	*trichostomus.*
	Without white median shade,	45.
45.	Median white stripe from base of wing,	*oregonicus.*
	Without median white stripe,	46.
46.	Fore wings with a white point near the end of the cell,	*bonifatellus.*
	Fore wings dark brown,	*caliginosellus.*
	Fore wings ashy gray,	*zeëllus.*
	Fore wings ochreous yellow,	47.
47.	Median and terminal spaces slightly ashy	*ulæ.*
	Median and terminal spaces not ashy,	*luteolellus.*

Crambus satrapellus. (Plate I., fig. 1.)

Chilo satrapellus Zinck., Germ. Mag., Vol. IV., p. 247 (1821).
Crambus satrapellus Zell., Chil. et Cram., p. 16 (1863).
Crambus aculeilellus Walk., Lep. Het., Vol. XXVII., p. 158 (1863).
Crambus elegantellus Walk., Lep. Het., Vol. XXVII , p. 179 (1863).
Crambus elegantellus Robs., Ann. Lyc. N. Y., Vol. IX., pp. 315, 316 (1869).
Crambus satrapellus Felt, Grass-eating Ins., p. 89 (1894).

Expanse of wings, 25–35 mm. Head and palpi yellowish gray; thorax light golden yellow; labial palpi slender, about the length of the thorax, pale cinereous fuscous on the outside, the under margin whitish. Fore wings much produced at the apex, golden yellow, rust brown on the costa; from the base to near the outer margin a sharply pointed, silvery-white stripe, with a long, acute tooth projecting on the under side, from the middle nearly to the subterminal line. Above its apex, and parallel with it, a small spindle-shaped, silvery-white stripe. Both stripes bordered with rust brown. Subterminal line with a very acute angle near the outer margin, just below the apex. Costal half of apex dark brown, outer marginal half white. Fringes, white next the terminal line, brown outwardly. Hind wings pale cinereous; fringes white. Abdomen and legs grayish white.

Habitat. — Florida, Georgia, Texas. Food plant and early stages unknown.

Crambus hastiferellus. (Plate I., fig. 4.)

Crambus hastiferellus Walk., Lep. Het., Vol. XXVII., p. 155 (1863).
Crambus quinquareatus Zell., Ex. Mic., p. 38, Plate I, fig. 16 (1877).
Crambus extorralis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 165 (1886).

Expanse of wings, 16 mm. Head, palpi and thorax above, golden fuscous; abdomen white with fuscous annulations. Fore wings golden fuscous, darker on the costa nearly to the terminal line. A broad, silvery-white stripe, nearly reaching the costa and basally bordered with a dark line, extends from the base nearly to the subterminal line, taper-

ing bluntly at the tip, which rests upon a cream-colored stripe extending across the line and there uniting with a white sub-apical spot. Subterminal line very oblique in its first third from the costa, then from an obtuse angle it runs straight, with the exception of a small blunt tooth, to the inner margin. Above the dark apical dash, a light triangular spot. Terminal space, below the light stripe, brown with a few dark lines. Below the silvery stripe the wing is lighter in color, with a darker wedge-shaped space on the outer part. Terminal line dark, brownish ochreous. Fringes metallic. Hind wings white.

Habitat. — Nova Scotia, Pennsylvania, Florida, Louisiana, Texas, California. Food plant and early stages unknown.

Crambus occidentalis. (Plate II., fig. 3.)

Crambus occidentalis Grote, Can. Ent., Vol. XII., p. 16 (1880).
Crambus occidentalis Grote, Can. Ent., Vol. XIII., p. 66 (1881).

Expanse of wings, 16 mm. Head, palpi and thorax above, ochreous brown. Fore wings ochreous, heavily dusted with fuscous; the white streak in the costal half of the wing dilated in the middle, with a prominent tooth on the lower side, which is bordered with a heavy, dark-brown shade, especially from the tooth to the base. The subterminal line forms an acute angle under the apical patch. Apex light, with a dark shaded patch in the centre. Five dark-brown venular dots in the terminal space. Hind wings pale fuscous.

Habitat. — California. Food plants and early stages unknown.

It differs from the other species in the prominent notch or tooth at the middle of the lower side of the white stripe, and by the heavy dark shades below the stripe.

Crambus minimellus. (Plate II., fig. 2.)

Crambus minimellus Robs., Ann. Lyc. N. Y., Vol. XI., p. 315 (1869).
Crambus minimellus Felt, Grass-eating Ins., p. 88 (1894).

Expanse of wings, 13–15 mm. Head, palpi and thorax dark shining fuscous. Fore wings glossy fuscous, with a

whitish stripe above the middle of the wing and below two fuscous longitudinal lines on the upper part; this whitish stripe extends from the base nearly to the subterminal line, where it ends acutely in a dark line reaching to the end of the wing. Bordering the acute end of the stripe, above and below, are two small, white, wedge-shaped spots, pointing inwardly. A diamond-shaped, silvery-white spot in the apex of the wing, with a dark streak and lighter patch above it. Median line dark brown, arising from the middle of the costa and sending a very acute angle outward, which encloses the end of the white stripe and gives off two outward and one inward acute angles below the stripe, and ends near the middle of the hind margin. Subterminal line, bordered on each side with white in the first part of its course, arises from the outer fourth of the costa and runs obliquely out beyond the end of the stripe, where it forms a right angle and extends to the hind margin within the anal angle, giving off a tooth inwardly in the middle of its course.

Habitat. — New York, Pennsylvania, Texas, Illinois. Early stages and food plant unknown.

Crambus argillaceëllus. (Plate II., fig. 1.)

Crambus argillaceëllus Pack., Pr. Bos. Soc. N. H., Vol. XI., p. 54 (1866).

Expanse of wings, 16 mm. Head, thorax and outside of the palpi cinereous brown, with a slightly bronzed hue. Fore wings cinereous brown, with a narrow white stripe increasing in width for one-half the length of the wing, when it tapers off acutely on the outer fourth; a brown apical patch on the costa, with a white one below it. Subterminal line forming a right angle at its costal third. Terminal space, below the apical spots, dark; two or three short white parallel lines run from the tip of the white stripe to the subterminal line. Fringes much paler. Hind wings dark, argillaceous above and beneath. Differs from all other species in its peculiar dark hue, especially on the hind wings.

Habitat. — Labrador. Early stages and food plant unknown.

CRAMBUS HAMELLUS. (Plate II., fig. 4.)

Tinea hamellus Thunb., Diss. Ent., p. 97, Plate IV , fig. 3 (1794).
Tinea Ensigerella Hüb., Tinea, Plate LIV., fig. 267 (1803).
Chilo Ensigerellus Zinck., Germ. Mag., Vol. II., p. 53 (1817).
Chilo ensigerellus Tr., Schm., Vol. IX., part 1, p. 79 (1832).
Crambus Ensigerellus Dup., Nat. Hist. Lep., Vol. X., p. 57, Plate CCLXXV. (1836).
Crambus Hamellus H. S., Vol. IV., p. 53 (1849).
Crambus Hamellus Wood, Ind. Ent., p. 215, No. 491 (1854).
Crambus hamellus Staint., Man., Vol. II., p. 181 (1859).
Crambus hamellus Zell., Chil et Cram., p. 17 (1863).
Crambus Hamellus Hein., Schm., Vol. I., p. 119 (1865).
Crambus hamellus Meyr., Handb. Br. Lep., p. 389 (1895).

Expanse of wings, 20–23 mm. Palpi shining fuscous on the outside ; head ashy brown ; thorax and fore wings brownish cinereous ; a snow-white stripe from the base to a point a little within the subterminal line, giving off a strong tooth near the middle ; costal margin narrow at the base, widening outwardly, and where the white stripe begins to taper the costal stripe is about as wide as the white stripe ; a very small oval streak above the end of the white stripe, sometimes reaching it. Subterminal line brown, bordered with white on each side, at the costa, and edged outwardly with dark lead-colored scales, extending down to a point beyond the end of white stripe, where it forms an obtuse angle, and then crosses the wing in a nearly straight line. Terminal space dark brown with a white triangle reaching to the apex ; below, ashy, with five elongate black spots. Terminal line above, dark brown. Fringes metallic gray, white at base, above. Hind wings pale fuscous ; fringes lighter.

Habitat. — Maine, Europe. Early stages and food plant unknown.

Crambus cypridalis. (Plate III., fig. 1.)

Crambus cypridalis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 165 (1886).

Expanse of wings, 30 mm. Head and palpi cinereous fuscous, whitish above; thorax and abdomen ochreous. Fore wings ochreous fuscous; a silvery-white stripe bordered with a very dark brown line extends from the base nearly to the subterminal line, tapering acutely at the outer end; above this portion another small, tapering white stripe. Terminal line forming a blunt angle at about one-third the width of the wing from the costa. Apex white, with a dark-brown patch. Five fine black lines between the veins in the terminal space. Fringe fuscous, with a white line at the base. Hind wings cream white.

Habitat. — Utah. Early stages and food plant unknown.

Crambus carpenterellus. (Plate I., fig. 5.)

Crambus carpenterellus Pack., Rep. Hayd. Surv., p. 548 (1873).

Expanse of wings, 28 mm. Head, palpi and thorax tawny ochreous. Fore wings ochreous fuscous, with a white stripe starting from the base and extending to near the subterminal line, where it ends in a point; at the basal third, a tooth on the costal side, and another one at the outer third on the opposite side, which ends in a dark line extending half the distance to the cross-line. Between this line and the point of the streak three other dark lines, parallel to this and gradually growing shorter, arise from the white streak. Below the streak the wing is lighter in color than elsewhere. Subterminal line bordered with white on the costa, slightly curving in its first third, nearly straight the remainder of its course and followed outwardly by a silvery line. Upon the apex a brown triangle with a white triangle above it. A series of five dark-brown marginal dashes. Fringes silvery fuscous. Hind wings much paler.

Habitat. — Mountains of Colorado. Early stages and food plant unknown.

Crambus pascuellus. (Plate I., fig. 3.)

Phalæna Tinea pascuella Linn., Syst. Nat., ed. X, p. 535 (1758).
Tinea pascuella Linn., Faun. Suec., ed. II., p. 355 (1761).
Tinea pascuella Fab., Syst Ent., p. 658 (1775).
Tinea Pascuella Wein. Verz., p. 134 (1776).
Tinea Pascuella Goeze, Ent. Beitr., Vol. III., part 4, p. 85 (1783).
Tinea Pascuella DeVillers, Ent. Linn., Vol. II., p. 460 (1789).
Tinea Pascuella Fab., Ent. Syst., Vol. III., part 2, p. 295 (1793).
Tinea Pascuella Schrank, Faun. Boic., Vol. II., part 2, p. 100 (1802).
Tinea Pascuella Hüb., Tinea, Plate V., fig. 51 (1803).
Chilo Pascuellus Zinck., Germ. Mag., Vol. II., p. 49 (1817).
Chilo pascuellus Tr., Schm., Vol. IX., part 1, p. 75 (1832).
Crambus pascuellus Steph., Ill. Br. Ent. Haust., Vol. IV., p. 320 (1834).
Crambus pascuellus Dup., Nat. Hist. Lep., Vol. X., Plate CCLXIX., fig. 1 (1836).
Crambus Pascuellus H. S., Schm., Vol. IV., p. 53 (1849).
Crambus Pascuellus Wood, Ind. Ent., p. 215 (1854).
Crambus pascuellus Staint., Man., Vol. II, p. 181 (1859).
Crambus pascuellus Zell., Chil. et Cram., p. 20 (1863).
Crambus Pascuellus Hein., Schm., Vol. I., p. 120 (1865).
Crambus pascuellus Praun, Tineidæ, Plate I., fig. 15 (1869).
Crambus floridus Zell., Beitr., Vol. I., p. 91 (1875).
Crambus floridus Felt, Grass-eating Ins., pp. 78, 86 (1894).
Crambus pascuellus Meyr., Handb. Br. Ent., p. 390 (1895).

Expanse of wings, 21–24 mm. Palpi fuscous on the outside; head white above; thorax white above and beneath, brownish ochreous on the sides. Fore wings brownish ochreous, with a broad white stripe extending through the wing very near the costa, and ending in an acute angle a short distance within the subterminal line; costal margin brownish fuscous, widening outwardly, but in no place more than half as wide as the white stripe; four or five silvery, black-margined streaks on the outer part of the wing, but not reaching the subterminal line; a white spot beyond and below the end of the white stripe; a white spot on each side of the subterminal line, on the costa. Subterminal line fuscous, arising a little beyond the outer fourth of the costa, extends outwardly to a point beyond the end of the white stripe, where it forms an obtuse angle and crosses the wing to the hind margin. Subterminal space below ashy gray,

with four or five black terminal points. Apex white, triangularly produced, with a terminal dark-brown line, a yellowish-brown costal spot and oblique streak before it. Fringes metallic gray, white at base above. Hind wings whitish, pale fuscous apically; fringes white.

Habitat. — Massachusetts, Texas, California, Europe. Food, grass.

"*Egg.* — Creamy white when first laid, gradually turning to a dark scarlet color before hatching. Form, elliptical oval; size, .39 mm. by .30 mm. The egg-shell has sixteen feeble longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .21 mm.; body diameter, .15 mm.; length, 1.15 mm. Head black, labrum yellowish, scattered hairs on the head; thoracic shield dark brown; body straw color with fine reddish blotches, giving it a pinkish cast. Scattered hairs grow from small tubercles. When about two weeks old the body is a dark mottled brown When a month old the larva is 1 cm. long." (Felt.)

CRAMBUS GIRARDELLUS. (Plate I., fig. 13.)

Crambus Girardellus Clem., Pr. Ph. Ac. Sci , p. 204 (1860).
Crambus nivihumellus Walk., Lep. Het., Vol. XXVII., p. 159 (1863).
Crambus girardellus Felt, Grass-eating Ins., pp. 73, 86 (1894).

Expanse of wings, 23–25 mm. Labial palpi pale fuscous on the sides, silvery white above and beneath; thorax whitish above, orange-yellow on the sides; abdomen white. Fore wings silvery white, with an orange-yellow stripe, bordered outwardly with dark-brown scales, extending from the base of the wing, beneath the median vein, to beyond the cell, where it turns up toward the apex of the wing. Terminal line brown, edged with yellow, with five short, dark-brown dashes before it on the posterior half of the wing. Hind wings pure white, sometimes smoky on the anterior half.

Habitat. — St. Martin's Falls, Albany River, Hudson's Bay, Ontario, Maine, New Hampshire, Massachusetts, New York, Pennsylvania, Maryland, Ohio. Food, grass.

"*Egg.* — Creamy white when first laid, but gradually changing to bright orange before hatching. Form, elliptical oval; size, .51 mm. by .33 mm. The egg-shell has seventeen longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .24 mm.; length, 1.05 mm. Head and thoracic shield a glistening black, body a reddish straw color; scattered hairs occur on the head and body; the hairs on the body grow from minute tubercles, which are concolorous with the body. When about a month old the larvæ are 2 cm. long. The head is yellowish, with irregular brown markings; the body is a slate color, with brown tubercles." (Felt.)

CRAMBUS LEACHELLUS. (Plate I., fig. 2.)

Chilo Leachellus Zinck., Germ. Mag., Vol. III., p. 114 (1818).
Crambus pulchellus Zell., Chil. et Cram., p. 18 (1863).
Crambus pulchellus Zell., Beitr., p. 89 (1872).
Crambus leachellus Felt, Grass-eating Ins., pp. 71, 85 (1894).

Expanse of wings, 24–30 mm. Head and thorax brassy brown; palpi brownish cinereous. Fore wings golden fuscous, with a broad silvery-white stripe, bordered by a fine dark line, extending outward from the base and ending in a point near the subterminal line; basal stripe narrow, less than half the width of the white stripe at the costa. A very small tooth in the middle on the lower side; a very small, spindle-shaped white spot above the outer end of the white stripe, sometimes connected with it; subterminal line brownish, edged outwardly by a silvery streak, arising from the outer fourth of the costa, forming an angle near the point of the white stripe, thence running straight across the wing and terminating just within the anal angle; from the end of the white streak a pale yellowish stripe extends outward to the terminal line, curving upward to the apex, above which is a brown triangular patch separated from the costa by a small white triangle. Subterminal space below ashy brown, with four or five indistinct black dashes. Terminal line golden fuscous. Fringes grayish metallic, white at base above.

Hind wings white in female, slightly yellowish in the male.

Habitat. — Ontario, Maine, Massachusetts, New York, New Jersey, Pennsylvania, Georgia, Texas, Illinois, California, Vancouver Island, Venezuela, Mendocino.

"*Egg.* — Creamy white in color when first laid, quickly changing to a scarlet and then to an intense geranium red; just before hatching the blackish head of the embryo shows through the thin shell very distinctly. Form nearly oval; size, .51 mm. by .39 mm. The egg-shell is quite fragile, and frequently collapses when the larva leaves it. There are twenty-two longitudinal ridges and numerous smaller transverse ridges. The circular markings around the micropyle are very characteristic.

"*Larva, First Stage.* — Head diameter, .21 mm.; body diameter, .18 mm.; length, 1 mm. Head a brownish black, clypeus yellowish, antennæ nearly colorless; scattered hairs occur on the head; thoracic shield brown, with a reddish tinge from the body contents; body a variable red, the color being the most intense in the thoracic region; there is a slight stigmatal line; tubercles blackish and bearing dark hairs; prolegs almost rudimentary. When about a month old the larvæ are 1.5 cm. long; the head is yellowish, with irregular black markings; the body is brown, with large blackish tubercles. When about six weeks old the larvæ are 3 cm. long and quite stout; the color has not changed." (Felt.)

Crambus unistriatellus. (Plate I., fig. 6.)

Crambus unistriatellus, Pack , Pr. Bos. Soc. N. H., Vol. XI., p. 54 (1866).
Crambus exesus Grote, Can. Ent., Vol. XII., p. 16 (1880).
Cramibus exesus Grote, N. A. Ent., Vol. I., p. 68, Plate V., fig. 7 (1880).
Crambus unistriatellus Felt, Grass-eating Ins., p. 85 (1894).

Expanse of wings, 25 mm. Head, palpi and abdomen very pale gray; palpi long, slender, acute; thorax and fore wings golden yellow, with metallic lustre. A broad, uninterrupted silvery-white band on each side, with a few dark scales, extends to the outer edge of the wing, expanding upwards on

the apex; edge of the brown stripe above the silvery band bordered with a few white scales towards the apex. A submarginal row of minute black dots. Fringe concolorous with the rest of the wing. Hind wings white above and beneath. Under side of fore wings and the legs pale gray.

Habitat. — Labrador, Maine, New Hampshire, New York, Pennsylvania, Minnesota, California. Early stages and food plant unknown.

CRAMBUS PRÆFECTELLUS. (Plate I., fig. 7.)

Chilo præfectellus Zinck., Germ. Mag., Vol. IV., p. 248 (1821).
Crambus involutellus Clem., Pr. Ph. Ac. Sci., p. 203 (1860).

Expanse of wings, 21–25 mm. Head, palpi and thorax cinereous with bronze lustre. Fore wings golden fuscous, with a silvery-white stripe bordered with a fine darker line, and tapering toward each end, from the base to near the subterminal line; a tooth in the middle on the lower side; a dark shade, with a light costal triangle above it and a light patch below it, extends from the apex to the subterminal line; costal margin wider than in *leachellus*, being more than one-half the width of the white stripe at the middle of the costa; subterminal space with four dark venular dashes. Fringes grayish metallic, with a white line at the base. Hind wings white or slightly cream colored; fringes white.

Habitat. — Canada, Massachusetts, New York, New Jersey, Colorado, Texas. Early stages and food plant unknown.

CRAMBUS DISSECTUS. (Plate II., fig. 12.)

Crambus dissectus Grote, Can. Ent., Vol. XII., p. 66 (1880).

Expanse of wings, 20 mm. Head and palpi above, white; thorax brown on the sides, white above; abdomen whitish, mottled with brown. Fore wings light brown. A white stripe, very narrow at the base and much dilated in the middle of the wing, where it sends out a long acute tooth behind. The hind margin white, more or less broken. Several very dark-brown parallel dashes run from the white stripe nearly to the subterminal line, and upon these dashes a white, diamond-shaped patch. On the costa, on each side

of the subterminal line, is a white patch. Apex brown, with a white patch below it. Terminal space with a white streak enclosing five very dark-brown dots. Fringes metallic, except at the base of apex. Hind wings smoky fuscous, with pale fringes.

Habitat. — Maine, New York. Early stages and food plant unknown.

Crambus bidens. (Plate I., fig. 8.)

Crambus bidens Zell., Beitr., p. 89 (1872).
Crambus bidens Grote, Can. Ent., Vol. XII., p. 77 (1880).

Expanse of wings, 18 mm. Head and thorax lustrous ochre-yellow; palpi acute, ochre-yellow. Fore wings bright ochre-yellow, with a few rust-brown scales. A few light patches on the inner margin. A very broad silvery-white stripe extends to the costa on one-half the length of the wing, then turns obliquely in a straight line. On the inner side it sends out an acute tooth, then runs in a straight line and meets the costal line at an acute point near the angle of the subterminal line. This line runs obliquely for one-third of its length, then, forming an obtuse angle, runs in a straight line an equal distance, where it forms a very blunt tooth and continues to the inner margin. On the costa a white spot on each side of the subterminal line; also one below the brown apex, and a larger one enclosing five dark-brown dots in the terminal space. Hind wings white, slightly dusted with ochreous.

Habitat. — Massachusetts, New York. Early stages and food plants unknown.

Crambus labradoriensis. (Plate III., fig. 7.)

Crambus Labradoriensis Chris., Stett. Ent. Zeit., Vol. XIX., p. 314 (1858).
Crambus labradoriensis Möschl., Wien. Monats., Vol. IV., p. 379 (1860).
Crambus labradoriensis Zell., Chil. et Cram., p. 21 (1863).
Crambus labradoriensis Pack., Pro. Bos. Soc. N. H., Vol. XI., p. 55 (1866).

Expanse of wings, 18–20 mm. Head and thorax fuscous brownish; lateral margin of the face, palpi above and beneath, at the base, and the apices of the scapulæ, white.

Fore wings slightly emarginate, long and rather narrow, ashy fuscous, mingled outwardly with clay yellow. Median white stripe narrow, remote from the costa, and ending near the middle of the wing in a bidentate apex. Whitish scales in spots and lines between the fuscous spot at the end of the stripe and the subterminal line, which is silvery and extends from the outer fourth of the costa to a point beyond the end of the white stripe, where it forms an obtuse angle and continues in a straight line to the hind margin, within the anal angle. Terminal space white, overlaid more or less, next to the subterminal line, with the ground color of the wing; a dark-brown costal triangle just within the apex. Terminal line dark brown above, followed by fine dark-brown dots. Fringes dark silvery gray. Hind wings fuscous cinereous.

Habitat. — Labrador, Ontario, Oregon. Early stages and food plant unknown.

Crambus dumetellus. (Plate III., fig. 2.)

Tinea Dumetella Hüb., Tineæ, Plate 58, figs. 389, 390 (1803).
Tinea Pratella Hüb., Tineæ, Plate V., fig. 29 (1803).
Argyroteuchia Dumetalis Hüb., Verz., p. 364 (1818).
Agriphila Pratalis Hüb., Verz., p. 365 (1818).
Chilo dumetellus Tr., Schm., Vol. IX., p. 80 (1832).
Crambus Dumetellus Steph., Ill. Br. Ent. Haust., Vol. IV., p. 321 (1834).
Crambus dumetellus Dup. Nat. Hist. Lep., Vol. X., p. 52, Plate CCLXIX. (1836).
Crambus Dumetellus H. S., Schm., Vol. IV., p. 54 (1849).
Crambus Dumetellus Wood, Ind. Ent., p. 215, No. 1493 (1854).
Crambus dumetellus Staint., Man., Vol. II., p. 181 (1859).
Crambus dumetellus Zell., Chil. et Cram., p. 24 (1863).
Crambus Dumetellus Hein., Schm., Vol. I., p. 122 (1865).
Crambus dumetellus Praun, Tineidæ, Plate 1, fig. 16 (1869).
Crambus trichusalis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 165 (1886).
Crambus dumetellus Meyr., Handb. Br. Ent., p. 391 (1895).

Expanse of wings, 20–25 mm. Palpi, head and thorax ochreous brown, the palpi somewhat darker on the outside. Fore wings ochreons brown, or dark ochreous brown, with a narrow costal white stripe extending nearly to the middle; a median white stripe extending from the base outward along

the cell, giving off a small tooth near the middle, and cut off more or less obliquely at the outer end, a little below and beyond which is another white streak; subterminal line dark brown, edged outwardly with metallic scales, arising at the outer fourth of the costa, where it is preceded by a white costal spot, and extending to a point beyond the end of the white stripe, then, forming an acute angle, extends with a slight inward curve to the hind margin. Subterminal space below ashy gray, with five more or less distinct terminal black points. Terminal line above dark brown; apical space occupied by two triangles, the lower one white, the upper brown; both separated from the subterminal line by a narrow streak of the ground color of the wing. Fringes silvery fuscous, whitish at the base, emarginate as in *pascuellus*. Hind wings fuscous; fringes lighter.

There are several specimens in the National Museum which are very much darker than any in my possession.

Habitat. — Texas, Colorado, Rocky Mountains, north of Montana (Geddes), Europe. Early stages and food plant unknown.

Crambus gausapalis. (Plate I., fig. 14.)

Crambus gausapalis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 167 (1886).

Expanse of wings, 22–24 mm. Palpi light ochreous, darker on the outside; head and thorax ochreous. Fore wings light ochreous, with scattered specks of brown; dark ochreous lines dusted with brown on all the veins beyond the cell; median line ochre-yellow, running obliquely from the middle of the costa about half-way to the apical angle, then, with a sharp angle, back to the cell, where, with another acute angle, it turns toward the outer margin but runs only a short distance. Subterminal line brown, edged outwardly with silvery scales, running evenly from the costa to near the outer margin, where it curves and runs to the hind margin. Terminal space darker, sprinkled with white; terminal line dark brown, replaced below by four dark-brown dots; outer margin falcate, apex acute; apical space light, with a large dark-brown patch on the costa. Fringes golden cinereous, with white at the base above.

Hind wings very pale gray, with a trace of the subterminal line below the apex; fringes lighter.

Habitat. — Sierra Nevada Mountains, California. Early stages and food plant unknown.

CRAMBUS LAQUEATELLUS. (Plate I., fig. 11.)

Crambus laqueatellus Clem., Pr. Ph. Ac. Sci., p. 203 (1860).
Crambus semifusellus Walk., Lep. Het., Vol. XXVII., p. 159 (1863).
Crambus laqueatellus Zell., Chil. et Cram., p. 24 (1863).
Crambus laqueatellus Zell., Beitr., Vol. I., p. 91 (1872).
Crambus laqueatellus Felt, Grass-eating Ins., pp. 79, 89 (1894).

Expanse of wings, 23 mm. Head luteous; thorax and palpi fuscous, the latter whitish beneath. Fore wings ochreous, with two silvery-white streaks separated by a fuscous streak; the outer silvery streak margined on the costa with fuscous; the inner one, which extends beyond the apical third, edged on the fold with fuscous. Beneath the fold the wing is pale yellowish with fuscous streaks along the submedian veins. Apex of the wing tinted with ochreous yellow, the veins streaked with silvery white; on the costa near the tip an oblique silvery streak, margined on both sides with fuscous. The subterminal silvery-white line much angulated, bending in below the apex, leaving a large whitish marginal patch streaked with dark parallel lines which end in dots before the terminal line. Fringes lustrous ochreous. Hind wings pale fuscous; fringes white.

Habitat. — Maine, Massachusetts, New York, Ohio, Illinois, Kentucky, Louisiana, Texas. Food, grass.

"*Egg.* — Creamy white when first laid, gradually turning to an orange color before hatching. Form subcylindrical; size, .42 mm. by .30 mm. There are sixteen longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .18 mm.; body diameter, .15 mm.; length, 1.15 mm. Head brownish black, with whitish hairs; thoracic shield light brown; body mottled with pale bright red and bearing blackish tubercles." (Felt.)

CRAMBUS ALBOCLAVELLUS. (Plate I., fig. 9.)

Crambus alboclavellus Zell., Chil. et Cram., p. 19 (1863).
Crambus alboclavellus Zell., Beitr., p. 92 (1872).
Crambus alboclavellus Felt, Grass-eating Ins., pp. 77, 88 (1894).

Expanse of wings, 18 mm. Palpi pale fuscous, white beneath; head whitish; thorax luteous. Fore wings brownish luteous, with a broad silvery-white stripe extending beyond the middle on the costa to the cell on the hind side, where it forms a tooth; the two sides then run obliquely and meet at an acute angle, the costal line sending out a tooth before meeting the other; beyond the silvery stripe the dark brown shades off into lighter brown or fuscous, and upon this space rest two white spots, one on the costa and one just before the subterminal line; hind margin much lighter, especially toward the base. Subterminal line brown, edged outwardly with silvery white, very straight to the angle under the apex, where it forms almost a right angle, then runs straight to the hind margin. A row of four or five black marginal points below the apex. Fringes with bronze lustre. Hind wings very pale ochreous, lustrous; fringes whitish.

Habitat. — Massachusetts, New York, New Jersey, Virginia, Ohio, Illinois, Kentucky, Texas, Ontario. Food plant, grass.

"*Egg.* — Creamy white when first laid, gradually turning to an orange-buff color before hatching. Form, elliptical oval; size, .42 mm. by .33 mm. There are about sixteen longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .225 mm.; body diameter, .14 mm.; length, .625 mm. Head a deep brown, thoracic shield a lighter brown; body a straw color, with a reddish mark along the middle of the back from the fourth to the ninth segments inclusive. Scattered light-colored hairs occur on the head and body." (Felt.)

Crambus agitatellus. (Plate I., fig. 10.)

Crambus agitatellus Clem., Pr. Ph. Ac. Sci., p. 203 (1860).
Crambus saltuellus Zell., Chil. et Cram., p. 22 (1863).
Crambus agitatellus Felt, Grass-eating Ins., p. 88 (1894).

Expanse of wings, 21 mm. Head and thorax pale luteous; labial palpi somewhat fuscous, white beneath. Fore wings ochreous, streaked with orange; a broad silvery-white streak, through which runs a longitudinal yellow stripe; a white patch between the silvery stripe and the subterminal line, another on the costa above it, one on the costa of the apex and another on the outer margin just below the brown apex. A whitish or yellow streak with five venular dots in the terminal space. Subterminal line very oblique in its first third from the costa, then straight to the hind margin. Broken fuscous lines specked with silvery scales along the veins above and beneath the middle of the silvery stripe. Fringes metallic, whitish at base of apex. Hind wings pale cinereous; fringes whitish.

Habitat. — Ontario, Maine, Massachusetts, New York, Illinois, Texas. Early stages and food plant unknown.

Crambus multilineëllus. (Plate I., fig. 12.)

Crambus multilineëllus Fern., Ent. Am., Vol. III., p. 37 (1887).

Expanse of wings, 26 mm. Palpi, head and thorax dull ochre-yellow. Fore wings bright ochre-yellow; a white stripe, extending nearly to the apex, leaving the extreme edge of the costa fuscous; a median white stripe from the base of the wing along the lower part of the cell, out as far as the subterminal line, the outer portion separated by an oblique yellow band. This band, between the two white stripes, edged on each side with a fine line of black and metallic lead-colored scales; similar lines along the intervenular spaces. All the lines terminate just before the subterminal line. Three or four oblique yellow lines, edged outwardly with white, cross the outer part of the costal

white stripe. The subterminal line, overlaid with metallic lead-colored scales, runs down near the outer margin of the wing, where it bends and runs to the hind margin, nearly parallel with the outer margin. A terminal row of five black dots. Fringes pale metallic lead color. Hind wings and fringes white. Abdomen, underside of body and the legs dull ochre-yellow.

Habitat. — Florida. Early stages and food plant unknown.

CRAMBUS ALBELLUS. (Plate III., fig. 5.)

Crambus albellus Clem., Pr. Ph. Ac. Sci., p. 204 (1860).
Crambus albellus Felt, Grass-eating Ins., pp. 76, 88 (1894).

Expanse of wings, 16 mm. Palpi, head, thorax and abdomen pure white. Fore wings white, with a few dark-brown flecks scattered over the hind portion. An oblique, pale-yellow, acutely angulated line from near the middle of the costa to the cell. The strongly angulated outer line silvery white, bordered on each side with yellow. A yellow line from the costa to the terminal line under the apex. A yellow spot on the apical space. Five black marginal dots, with a short blackish line above. Fringe yellow, with golden lustre. Hind wings pale gray or whitish.

" *Egg.* — Creamy white when first laid, gradually turning to pale straw color before hatching. Form, nearly oval; size, .39 mm. by .33 mm. The egg-shell has eighteen longitudinal ridges and numerous smaller transverse ridges.

" *Larva, First Stage.* — Head diameter, .175 mm.; body diameter, .125 mm.; length, .75 mm. General color a smutty white, head darker, and the thoracic shield a little darker than the body. Scattered brown hairs occur on the head; rows of numerous small tubercles occur on the body." (Felt.)

Habitat. — Maine, Massachusetts, New York, New Jersey, Pennsylvania, Canada, Labrador. Food, grass.

CRAMBUS PUSIONELLUS. (Plate III., fig. 6.)

Crambus pusionellus Zell., Chil et Cram., p. 16 (1863).
Crambus pusionellus Zell., Stett. Ent. Zeit., Vol. XXXIII., p. 470, Plate II., fig. 3 (1872).
Crambus pusionellus Zell., Exot. Micro., p. 33 (1877).

Expanse of wings, 15 mm. Palpi white, brownish on the outside; head and thorax white. Fore wings lustrous white, with a few scattered brown scales; median line brown, arising from middle of costa, extending out to the end of the cell, thence nearly straight to the hind margin a little beyond the middle, but broken on the fold, gradually dilated in the latter part of its course; subterminal line brown, double, arising from outer fourth of costa, extending outwardly to near the middle of hind margin, then running to outer fourth of hind margin, giving off an inward angle on the fold. A brown spot on the costa, just before the apex, sometimes extended into a streak. Subterminal space more or less stained with brownish. Terminal line dark brown, with three dark-brown dots above the anal angle. Fringes whitish, more or less stained with metallic fuscous. Hind wings and fringes white.

Habitat. — California. Early stages and food plants unknown.

Crambus hortuellus. (Plate II., fig. 11.)

Tinea Hortuella Hüb., Tineæ, p. 29, Plate VII., figs. 45, 46 (1803).
Tinea Cespitella Hüb., Tineæ, p. 29, Plate VII, fig. 45 (1803)
Tinea Falsella Schrank, Faun. Boic., Vol. II., p. 103 (1804).
Chilo Hortuellus Zinck., Germ. Mag., Vol. II., p. 62 (1817).
Chilo hortuellus Tr., Schm., Vol. IX., p. 84 (1832).
Crambus hortuellus Steph., Ill. Br. Ent. Haust., Vol. IV., p. 322 (1834).
Crambus hortuellus Dup., Nat. Hist. Lep., Vol. X., Plate CCLXIX., fig. 1 (1836).
Crambus Hortuellus H. S, Schm., Vol. IV., p. 59 (1849).
Crambus Hortuellus Wood, Ind. Ent., p. 216, No. 1497 (1854).
Crambus hortuellus Staint., Man., Vol. II., p. 182 (1859).
Crambus hortuellus Zell., Chil. et Cram., p. 24 (1863).
Crambus Hortuellus Hein., Schm., Vol. I., p. 125 (1865).
Crambus topiarius Zell., Stett. Ent. Zeit., Vol. XXVII., p. 155 (1866).
Crambus hortuellus Praun, Tineidæ, Plate II., fig. 3 (1869).
Crambus topiarius Grote, Can. Ent., Vol. XII., p. 17 (1880).
Crambus topiarius Grote, Papilio, Vol. II., p. 74 (1882).
Crambus topiarius Felt, Grass-eating Ins., pp. 75, 87 (1894).
Crambus topiarius Scud., Ins. Life, Vol. VII., p. 1 (1894).
Crambus hortuellus Meyr., Handb. Br. Ent., p. 391 (1895).

Expanse of wings, 16–22 mm. Palpi pale cinereous, shining fuscous on the outside; head and thorax pale cinereous. Fore wings very pale cinereous, gradually changing to ochreous outwardly; intervenular spaces fuscous brown; a brown oblique line, arising a little before the middle of the costa, runs obliquely half way to the cell, then bends toward the submarginal line and nearly joins another oblique costal line of the same color; subterminal line fuscous brown, edged outwardly with dark lead-colored scales, arising from the outer third of the costa, crosses the wings to the outer fourth of the hind margin, forming an obtuse angle in the middle of its course; an oblique leaden streak in the apical portion of the subterminal space. Terminal line black above, followed by three black dots below. Fringes silvery gray. Hind wings pale gray to dark gray, with a darker terminal line not reaching the anal angle; fringes whitish. (Fig. 1, *f.*)

Habitat. — Maine, Massachusetts, New York, California, Europe. Food, grass, cranberry, sheep-sorrel.

"*Egg.* — When first laid, pellucid white, obovate, broadly rounded at both extremities, but slightly more so at base than at summit; broadest barely below the middle, 0.36 mm. high and 0.3 mm. broad, with about twenty-three straight and vertical ribs of slight elevation reaching to the dome of the summit, their interspaces crossed by finer, horizontal, raised cross-lines, which traverse also the vertical ribs, giving them a beaded appearance, the surface thus broken up into quadrangular cells whose length (the width

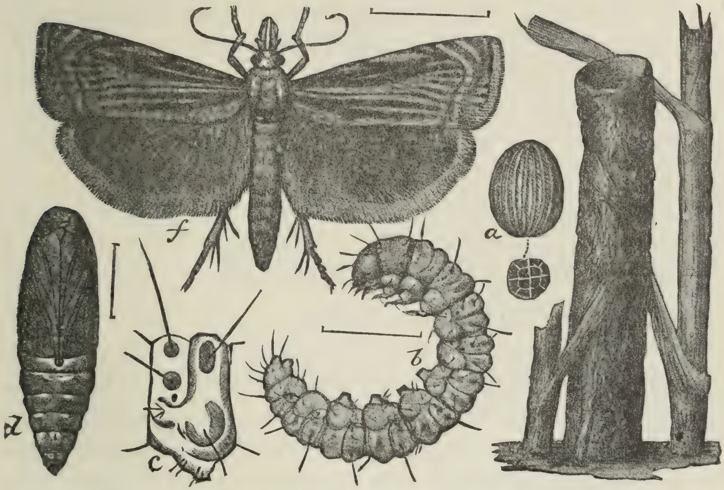

FIG. 1.— *Crambus hortuellus:* *a*, egg, with summit much enlarged; *b*, mature larva; *c*, one of the abdominal segments of larva; *d*, pupa; *e*, nest of young larvæ in grass; *f*, imago — all enlarged. — From "Insect Life."

of the interspaces between the ribs) in the middle of the egg is 0.04 mm., and whose height is scarcely 0.02 mm., the surface itself very delicately shagreened. On the dome of the summit the surface is broken into polygonal cells which are about 0.04 mm. in diameter below, and grow smaller toward the apex." (Fig. 1, *a*.) (Scudder.)

"*Larva, First Stage.* — Head diameter, 0.2 mm.; body diameter, 0.125 mm.; length, 0.99 mm. General color a smutty white; head a little darker than the rest of the body. Scattered hairs occur on the head; numerous small dark-colored tubercles occur on the body, each bearing at least one hair." (Felt.)

"*Larva, Last Stage.* — Head shining luteo-castaneous, the ocellar field, labrum and clypeus black. Body pallid fuliginous, the harder parts glistening; dorsal shield of first thoracic segment luteous, inconspicuous; surface covered with longer or shorter erect bristles, which are very fine, and taper to an exquisitely fine point; they are blackish at base, but beyond testaceous; the longer ones are nearly as long as the breadth of the body, and are situated in lateral and infrastigmatal series; the shorter ones are hardly as long as the segments, and are distributed on the sides of the body; there is also a series of intermediate in length and laterodorsal in position, situated in the middle of the larger anterior division of the segments, while the lateral series lies on the smaller posterior section; under surface and prolegs pallid, the claws luteous. Length, 15 mm." (Fig. 1, *b* and *c.*) (Scudder.)

"*Chrysalis.* — Nearly uniform, very pale honey yellow, more pallid beneath; the wings, excepting at base, with a very slight olivaceous tinge; all the thoracic and the first two abdominal segments, as well as the wings and legs, finely edged at the incisures with dark castaneous, darkest near the head; all the abdominal segments are bordered posteriorly, at least on the dorsal surface, with pale testaceous; lips of spiracles fuscous; cremaster blackish or blackish fuscous. Length, 7.75 mm.; breadth, 2.25 mm." (Fig. 1, *d.*) (Scudder.)

CRAMBUS PERLELLUS. (Plate III., fig. 14.)

Phalæna Perlellus Scop., Ent. Carn., p. 243, No. 620 (1763).
Tinea Argentella Fab., Syst. Ent., p. 658 (1775).
Tinea Perlella Wien. Verz., p. 134 (1776).
Tinea Perlella Knoch., Beitr., Vol. I., p. 68, Plate IV., fig. 6 (1781).
Tinea Perlella Goeze, Ent. Beitr., Vol. III., part 4, p. 142 (1783).
Tinea Perlella Schrank, Faun. Boic., Vol. II., p. 102 (1793).
Tinea Dealbella Thunb., Diss. Ent., Vol. VII., p. 84 (1794).
Tinea perlella Fab., Ent. Syst., Vol. III., part 2, p. 292 (1794).
Tinea argentella Fab., Ent. Syst., Vol. III., part 2, p. 296 (1794).
Crambus argenteus Fab., Ent. Syst., Suppl., p. 471 (1799).
Tinea Perlella Hüb., Tineæ, Plate VI., fig. 40 (1803).
Chilo Perlellus Zinck., Germ. Mag., Vol. II., p. 97 (1817).
Chilo Perlellus Treits., Schm. Eur., Vol. IX., part 1, p. 129 (1832).
Crambus argyreus Steph., Ill. Br. Ent. Haust., Vol. IV., p. 318 (1834).
Crambus Arbustorum Steph., Ill. Br. Ent. Haust., Vol. IV., p. 319 (1834).
Crambus argentellus Steph., Ill. Br. Ent. Haust., Vol. IV., p. 319 (1834).
Crambus perlellus Dup., Nat. Hist. Lep., Vol. X., p. 114, Plate CCLXXIV., fig. 2 (1836).
Crambus Perlellus H. S., Schm., Vol. IV., p. 66 (1849).
Crambus perlellus Zell., Stett. Ent. Zeit., Vol. X., p. 313 (1849).
Crambus perlellus Zell., Bresl. Zeit., Vol. III., p. 11 (1850).
Crambus Argentellus Wood, Ind. Ent., p. 215, No. 1488 (1854).
Crambus perlellus Staint., Man., Vol. II., p. 184 (1859).
Crambus perlellus Zell., Chil. et Cram., p. 49 (1863).
Crambus innotatellus Walk., Lep. Het., Vol. XXVII., p. 156 (1863).
Crambus inornatellus Walk., Lep. Het., Vol. XXVII., p. 157 (1863).
Crambus sericinellus Zell., Chil. et Cram., p. 49 (1863).
Crambus inornatellus Clem., Pr. Ent. Soc. Ph., Vol. II., p. 418 (1864).
Crambus Perlellus Hein., Schm., Vol. I., part 2, p. 143 (1865).
Crambus perlellus Praun, Tineidæ, Plate II., fig. 15 (1869).
Crambus sericinellus Grote, Can. Ent., Vol. XIII., p. 66 (1881).
Crambus innotatellus Felt, Grass-eating Ins., pp. 74, 87 (1894).
Crambus perlellus Meyr., Handb. Br. Ent., p. 393 (1895).

Expanse of wings, 20 mm. Palpi, head and thorax pure silvery white. Fore wings very lustrous, pure silvery white. Hind wings and abdomen white, with a slightly cinereous

tint, especially on the apical part of the wings. All the fringes white.

Habitat. — Nova Scotia, New Brunswick, Quebec, Ontario, Maine, New Hampshire, Massachusetts, New York, Ohio, Illinois, California. Food, grass.

"*Egg.* — Creamy white when first laid, gradually changing to a scarlet color before hatching. Form, elliptical oval; size, .45 mm. by .36 mm. The egg-shell has sixteen longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .19 mm.; body diameter, .15 mm.; length, 1.05 mm. Body a dull straw color, with irregular reddish blotches on the dorsum. Scattered light-colored hairs occur on the head and body." (Felt.)

Crambus turbatellus. (Plate III., fig. 13.)

Arequipa turbatella Walk., Lep. Het., Vol. XXVII., p. 196 (1863).
Crambus bipunctellus Zell., Chil. et Cram., p. 23 (1863).
Crambus bipunctellus Robs., Ann. Lyc. N. Y., Vol. IX., p. 313 (1870).
Crambus turbatellus Felt, Grass-eating Ins., p. 86 (1894).

Expanse of wings, 22–25 mm. Head, palpi, thorax and fore wings snow white, the last with the median stripe represented by one or two dark-brown dots at the end of the cell, and one or two similar ones below the outer fourth of the cell. The subterminal line consists of a row of dark-brown dots angulated beyond the end of the cell; a terminal row of seven black dots, the one nearest the apex elongated. Fringes white. Hind wings snow white, sometimes with a central pale fuscous shade. Fringes snow white.

Habitat. — Canada, New York, Pennsylvania, Ohio, Illinois. Food plants and early stages unknown.

CRAMBUS ELEGANS. (Plate IV., fig. 8.)

Crambus elegans Clem., Pr. Ph. Ac. Sci., p. 204 (1860).
Crambus terminellus Zell., Chil. et Cram., p. 27 (1863).
Crambus elegans Zell., Stett. Ent. Zeit., Vol. XXXIII., p. 473, Plate II., fig. 5 (1872).
Crambus elegans Zell., Beitr., p. 93 (1872).
Crambus elegans Zell., Exot. Mic., p. 45 (1877).
Crambus elegans Felt, Grass-eating Ins., pp. 74, 86 (1894).

Expanse of wings, 12–15 mm. Palpi white above, slightly fuscous on the outside; head and thorax white, fuscous on the sides. Fore wings white; base of costa streaked with bright brown with a brassy lustre; a patch of brown on the hind margin near the base, and a short curved streak near its middle, which forms with its opposite, when the wings are closed, a semicircular dorsal line, beyond which the wing is thickly dusted with brown; a broad brown band, very broad on the costa, where it encloses a small white spot and a nearly straight brown subterminal line resting on a silvery-white ground. A marginal row of fine black points on the silvery terminal space. Fringes metallic cinereous. Hind wings pale lustrous cinerous, with lighter fringes.

Habitat. — Ontario, Maine, Massachusetts, New York, New Jersey, Illinois, Ohio, Pennsylvania, Maryland, Texas. Food, grass.

"*Egg.* — Creamy white when first laid, gradually turning to an orange-buff color before hatching. Form, oval; size, .42 mm. by .30 mm. The egg-shell has sixteen longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .2 mm.; body diameter, .125 mm.; length, 1.09 mm. Head and thoracic shield light brown; body a dirty straw color. Scattered hairs occur on the head and body." (Felt.)

CRAMBUS MYELLUS. (Plate II., fig. 7.)

Phalæna Pinetella Scop., Ent. Carn., p. 244 (1763).
Tinea Conchella Wien. Verz., p. 134 (1776).
Tinea Pinetella Knoch., Beitr., Vol. I., Plate IV., fig. 5 (1781).
Tinea conchella Wien. Verz., Illig. ed , Vol. II., p. 83 (1801).
Tinea Myella Hüb., Tineæ, Plate VI., fig. 37 (1803).
Tinea Pinetella Schrank, Faun. Boic., Vol. II., p. 101 (1804).
Bombyx Pineti Esp., Suppl., p. 54, Plate LXXXIX., figs. 4, 5 (1807).
Chilo Conchellus Zinck., Germ. Mag , Vol. II., p. 74 (1817).
Catoptria Conchalis Hüb., Verz., p. 365 (1818).
Chilo conchellus Tr., Schm., Vol. IX , part 1, p. 97 (1832).
Crambus conchellus Dup., Nat. Hist. Lep., Vol. X., p. 91, Plate CCLXXI. (1836).
Crambus Myellus H. S., Schm., Vol. IV., p. 64 (1849).
Crambus Hercyniæ Hein., Bresl. Zeit., p. 3 (1854).
Crambus latiradiellus Walk., Lep. Het., Vol. XXVII., p. 157 (1863).
Crambus interruptus Grote, Can. Ent , Vol. IX., p. 101 (1877).
Crambus interruptus Grote, Can. Ent., Vol. XII., p. 15 (1880).
Crambus myellus Meyr., Handb. Br. Lep., p. 392 (1895).

Expanse of wings, 19–24 mm. Head white above; palpi white above and beneath, brown on the outside; thorax white above, brownish on the sides. Fore wings pale ferruginous, with a snow-white stripe extending through the middle of the wing from the base to near the outer border; this stripe and also the apical portion of the wing edged with dark ferruginous; two slightly curving, oblique, dark ferruginous bars cross the white stripe, one at the middle of the wing, the other very near the outer end of the stripe. A terminal row of black dots. Fringes dark smoky fuscous, cut by white in three or four places. Hind wings pale fuscous.

Habitat. — Nova Scotia, Maine, Europe. Early stages and food plant unknown.

CRAMBUS LUCTIFERELLUS LUCTUELLUS. (Plate II., fig. 8.)

Crambus luctuellus H. S., Schm., Vol. VI., p. 145, Plate III., fig. 21 (1852).

Expanse of wings, 20–22 mm. Head white above and in front; palpi white above and beneath, dark brown on the outside. Fore wings dark cinnamon brown, with a white stripe through the middle, extending from the base to near the outer margin, gradually widening outwardly, and interrupted by two broad, oblique, dark-brown bars, the inner one a little beyond the middle of the wing, the outer one very near the end of the white stripe, each curved on the sides toward each other. A terminal row of black dots. Fringes dark smoky brown, metallic. Hind wings fuscous.

Habitat. — Labrador, Washington, Europe. Early stages and food plant unknown.

CRAMBUS VULGIVAGELLUS. (Plate V., fig. 15.)

Crambus vulgivagellus Clem., Pr. Ph. Ac. Sci., p. 204 (1860).
Crambus aurifimbrialis Walk., Lep. Het., Vol. XXVII., p. 157 (1863).
Crambus chalybirostris Zell., Chil. et Cram., p. 40 (1863).
Crambus vulgivagellus Riley, Dept. Agr., 1881–82, pp. 179–183 (1881).
Crambus vulgivagellus Saund., Can. Ent., Vol. XIII., pp. 181, 199 (1881).
Crambus vulgivagellus Lintn., Rep. Ins. N. Y., Vol. I., p. 127 (1882).
Crambus vulgivagellus Fern., Stand. Nat. Hist., Vol. II., p. 276 (1885).
Crambus vulgivagellus Osborn, Ins. Life, Vol. VI., pp. 72, 78 (1893).
Crambus vulgivagellus Felt, Grass-eating Ins., pp. 69, 85 (1894).

Expanse of wings, 20–39 mm. Palpi very long, heavily scaled at the tip, luteous, dark fuscous on the outside; head and thorax luteous. Fore wings luteous or dull yellowish, with numerous fuscous streaks formed by atoms between the veins, and two in the cell. A terminal line of seven black dots. Fringes with a golden lustre. Hind wings fuscous; fringes long, pale yellowish. (Fig. 2, *d.*)

This is a very common insect, and the amount of damage done by the larvæ is very great, hundreds of acres of grass land sometimes being destroyed. The larva spins a delicate web among the roots of the grass, and gradually forms a tube in which it is entirely concealed. As it increases in size it extends the tube downward into the ground, and when the insect is full grown the tube is sometimes nearly two inches in length.

FIG. 2. — *Crambus vulgivagellus*: *a*, larva; *b*, the larval case in the grass; *c*, the cocoon in the ground; *d*, the moth, a dark specimen; *e*, wing of a light specimen; *f*, the moth at rest; *g*, the egg enlarged, its natural size shown beside it. — From the Department of Agriculture.

Habitat. — Nova Scotia, Ontario, Massachusetts, New York, New Jersey, Pennsylvania, North Carolina, Ohio, Illinois, Missouri, Texas, California, Vancouver Island. Food, grass, wheat, rye and other grains.

"*Egg.* — A pale straw color when first laid, gradually turning to an ochreous buff color before hatching. Form, elliptical oval; size, .45 mm. by .36 mm. The egg-shell has twenty longitudinal ridges and numerous smaller transverse ridges. (Fig. 2, *g*.)

"*Larva, First Stage.* — Head diameter, .19 mm.; body diameter, .175 mm.; length, 1.25 mm. Head a dark brown; thoracic shield olive, and the body a straw-yellow color. Scattered light-colored hairs occur on the head and on the numerous small brownish tubercles on the body.

"*Larva, Late in the Fall.* — Length, 2.5 mm. Head jet black; thoracic shield a deep brown; body brown, with deep-brown tubercles. The fifth to thirteenth segments inclusive are divided into cephalic and caudal portions by a short transverse constriction." (Fig. 2, *a.*) (Felt.)

"*Cocoon.* — Average length, .9 inch; diameter at the broadest part, .24 inch. The shape is subcylindrical, but varying from an almost uniform diameter to an enlargement of the lower portion to twice the diameter of the upper part." (Fig. 2, *c.*) (Lintner.)

"*Pupa.* — Average length, about .4 inch; average greatest diameter, .1 inch. Color, pale brown. Head case projected at the tip, and eye cases prominent. Tip of wing covers rounding over the segment, the inner wing cover showing its margin over more than three segments. The stigmata appear as minute tubercles. Anal tip dark brown, blunt, and slightly excavated beneath." (Lintner.)

Crambus biothanatalis. (Plate IV., fig. 1.)

Crambus biothanatalis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 166 (1886).
Crambus behrensellus Fern., Ent. Am., Vol. III., p. 37 (1887).

Expanse of wings, 17–20 mm. Palpi, head and thorax ochre-yellow. Fore wings light ochreous, thickly sprinkled with fuscous; median space lighter, with two broken ochre cross-lines forming scallops on the costal half of the wing, each with a tooth inwardly below the middle. A terminal row of seven black points, resting on an ochre-yellow band. Fringes dull golden, with metallic lustre. Hind wings and abdomen fuscous.

Habitat. — California. Early stages and food plant unknown.

Crambus ruricolellus. (Plate II., fig. 14.)

Crambus ruricolellus Zell., Chil. et Cram., p. 40 (1863).
Crambus ruricolellus Felt, Grass-eating Ins., pp. 67, 84 (1894).

Expanse of wings, 18–20 mm. Palpi pale ochreous, tinged with fuscous on the outside; head and thorax pale

ochreous. Fore wings very pale ochreous, with orange-brown scales arranged in lines along the interspaces, more or less diffused on the costal half; a median line of orange-brown scales arising from the middle of the costa, extending out to the end of the cell, where it curves and runs in a nearly straight line to the basal third of the hind margin; a subterminal line, arising from the outer third of the costa, forms a semicircle to a point two-thirds across the wing, then runs nearly straight to the hind margin. Terminal line composed of a marginal row of brown dots. Fringes golden. Hind wings pale gray, darker outwardly; fringes lustrous white.

Habitat. — Ontario, Maine, New Hampshire, New York, Pennsylvania, Ohio, Illinois. Food, grass and sheep sorrel.

"*Egg.* — Creamy white when first laid, gradually turning to an orange-buff color before hatching. Form, elliptical oval; size, .41 mm. by .33 mm. The egg-shell has twenty longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .225 mm.; body diameter, .175 mm.; length, 1.2 mm. Head nearly black; thoracic shield a dark reddish brown; body whitish translucent, with many pale rufous spots on the dorsum of the fifth to the twelfth segments, inclusive. Scattered dark-colored hairs occur on the head and body. Late in the fall the head and thoracic shield are almost black, the pale rufous spots have developed into dark-brown tubercles, and the body has become deep brown." (Felt.)

Crambus anceps. (Plate II., fig. 10.)

Crambus anceps Grote, Can. Ent., Vol. XII., p. 17 (1880).

Expanse of wings, 18 mm. Head, palpi and thorax dark fuscous. Fore wings dark brownish fuscous, crossed by two dark, reddish-brown angulated lines, which seem to be formed of short parallel dashes located so as to form strong outward angles above the middle of the wing, then curving in for a short distance and running parallel to the outer margin. These lines are connected with each other by a

dark, reddish-brown stripe above and parallel to the fold. Median line fused with a dark outer discal spot. Fringes metallic fuscous. Hind wings fuscous, with traces of subterminal line.

Habitat. — California. Early stages and food plant unknown.

Crambus teterrellus. (Plate III., fig. 10.)

Chilo teterrellus Zinck., Germ. Mag., Vol. IV., p. 252 (1821).
Crambus camurellus Clem , Pr Ph. Ac. Sci., p. 203 (1860).
Crambus terrellus Zell., Chil. et Cram., p. 27 (1863).
Crambus teterrellus Murtf., Bull. U. S. Dep. Agr., No. 30, p. 53 (1893).
Crambus teterrellus Felt, Grass-eating Ins , pp 66, 84 (1894).

Expanse of wings, 15–21 mm. Palpi fuscous, whitish above; head whitish; thorax whitish above, reddish fuscous on the scapulæ. Fore wings pale ochreous, dusted with fuscous, with an irregular fuscous patch on the outer part of the cell and in the submedian space, extended more or less toward the base of the wing; a faint brown median line, arising from the costa a little beyond the middle, forms an outward angle at the end of the cell and another on the median space, then terminates at the middle of the hind margin; the subterminal line forms an obtuse angle a little above the middle of the wing, edged outwardly by a faint silvery line. A terminal row of black points. Fringes dark, but with a silvery hue. Hind wings light gray; fringes lighter.

Habitat. — Maine, New York, Pennsylvania, Ohio, North Carolina, Georgia, Florida, Alabama, Missouri, Texas. Food, grass.

"*Egg.* — Obconical, .5 mm. long, beautifully sculptured, under the lens, with longitudinal ridges and finer cross-lines, giving it a checkered appearance. Color, bright salmon pink.

"*Larva.* — At first of a dingy cream white, minutely sprinkled with brown, with brown head. At maturity 15 mm. in length by 2 mm. in diameter, subcylindrical, slightly larger across the thoracic segments. Color yellowish or greenish white, with dull-green medio-dorsal stripe.

The surface is much roughened with impressed lines, with conspicuous raised corneous plates, from each of which arises a long, coarse, tapering, yellow-golden hair. Head with protruding lobes and rugose surface, and of a dull whity-brown color. Cervical shield inconspicuous, darker than the head." (Miss Murtfeldt.)

Crambus decorellus. (Plate I., fig. 15.)

Chilo decorellus Zinck., Germ. Mag., Vol. IV , p. 250 (1821).
Crambus polyactinellus Zell., Chil. et Cram., p. 25 (1863).
Crambus decorellus Zell., Beitr , Vol. I., p. 92 (1872).
Crambus Goodellianus Grote, Can. Ent., Vol. XII., p. 17 (1880).
Crambus bonusculalis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 167 (1886).
Crambus decorellus Fern., Ent. Am., Vol. IV., p. 44 (1888).
Crambus decorellus Felt, Grass-eating Ins., p. 84 (1894).

Expanse of wings, 19 mm. Palpi, head, thorax and abdomen very pale ochreous. Fore wings pale ochreous, with the veins shaded with fuscous; two dark ochre cross-lines, the median at the outer edge of the cell bent at its first third, and an outward tooth at its second; subterminal line edged on the outer side with fuscous; marginal band ochre-yellow, enclosing a row of black dots. Fringe metallic, black at base, iridescent golden outwardly. Hind wings white or ochreous, tinged with golden outwardly.

Habitat. — Massachusetts, Maryland, Pennsylvania, Georgia, Texas. Early stages and food plant unknown.

Crambus coloradellus. (Plate III., fig. 8.)

Crambus coloradellus Fern., Can. Ent., Vol. XXV., p. 95 (1893).

Expanse of wings, 22 mm. Head, palpi, thorax and fore wings pale silvery straw color; palpi darker on the outside. A white stripe extends from the base of the wing through the cell to the outer margin, bifid beyond the cell. All the veins more or less indicated by pale yellow, edged on each side with a more or less broken row of black scales. A pale-yellow median line crosses the wing at the end of the

cell, where it rounds outwardly and runs nearly straight and vertical to the hind margin. Subterminal line curved within the apex, then running to the hind margin. Both of these lines are faint, and the subterminal is edged on the outside with silvery scales. Terminal row of black dots in a straight line, not following the margin at the lower part, where it rounds outwardly. Fringes silvery metallic. Hind wings white, slightly stained with pale fuscous on the apex.

Habitat. — Colorado. Early stages and food plant unknown.

Crambus bolterellus. (Plate II., fig. 15.)

Crambus bolterellus Fern., Ent. Am., Vol. III., p. 37 (1887).

Expanse of wings, 22 mm. Palpi, head and thorax pale ochre-yellow, the palpi touched with fuscous on the outer side; patagiæ overlaid with lead-colored scales. Fore wings white, broadly edged with fuscous on the costa; behind this edging a dull-colored stripe extending from the basal fourth of the cell to the apex, the remaining intervenular spaces of the same color. An oblique reddish-brown line crosses the wing a little beyond the end of the cell, with a slight inward angle near vein 2 and a strong outward angle beyond the end of the cell. A second line crosses the wing rather more than half way between the other and the outer margin, of the same color and similarly angulated below the costa, but following the outline of the outer margin below the angle. A row of six or seven black points on the intervenular spaces, at the end of the wing. Fringes pale silvery metallic. Hind wings dull white, with a pale fuscous terminal line not reaching the anal angle. Fringes white.

Habitat. — Texas. Early stages and food plant unknown.

Crambus hulstellus. (Plate III., fig. 3.)

Crambus hulstellus Fern., Can. Ent., Vol. I., p. 56 (1885).
Crambus hulstellus Felt, Grass-eating Ins., p. 83 (1894).

Expanse of wings, 26 mm. Head, thorax and fore wings chalky white; palpi somewhat fuscous on the outside, remainder of the surface white. Fore wings crossed by a twice

angulated brown median line, much darker and heavier on the angles, starting from a point a little below the costa and extending a little beyond the end of the cell, where the first acute angle is formed. The line then runs obliquely across the wing to the middle of the hind margin, forming the second angle just below the cell, where it becomes nearly obsolete. A double yellowish line, starting from the costa near the outer fourth and curving downward, runs nearly parallel with the outer margin to the hind margin, just within the anal angle. Terminal space yellowish, fusing with the line so that it appears double only at the costa; a row of seven black points along the outer margin. Six geminate brown dashes between the median and subterminal lines; three dark-brown elongated patches between the base and the median line. Fringes white, with the base silvery. Hind wings sordid white, with a slightly darker terminal border. Fringes pure white.

Habitat.—Texas. Early stages and food plants unknown.

Crambus attenuatus. (Plate III., fig. 4.)

Crambus attenuatus Grote, Can. Ent,, Vol. XII., p. 18 (1880).
Crambus attenuatus Grote, Can. Ent., Vol. XIII., p. 78 (1881).

Expanse of wings, 25 mm. Palpi, head and thorax white, thickly sprinkled with fuscous. Fore wings narrow, pale cinereous sprinkled with fuscous; a poorly defined, dull-whitish stripe, crossed beyond the cell by an oblique brown line, sometimes indistinct, extends from the base to the outer margin. Subterminal line whitish, bordered on each side with fuscous, running very obliquely from the costa to below the apex, then, more indistinctly marked, very closely following the terminal line. A row of brown dots in the terminal space. Fringes cinereous, with the base fuscous, and the outer edge with metallic lustre. Hind wings fuscous; fringes white.

Habitat. — California, Columbia, Vancouver Island. Early stages and food plant unknown.

CRAMBUS ALBILINEËLLUS. (Plate II., fig. 5.)

Crambus albilineëllus Fern., Can. Ent., Vol. XXV., p. 94 (1893).

Expanse of wings, 26 mm. Head, palpi, thorax and fore wings dull ochre-yellow. The palpi are darker on the outside, and the subcostal, median and veins 5 to 10 are white. A stripe of lead-colored scales extends from the base of the wing just above and parallel to vein 1 to the outer cross-line, and a similar stripe occurs between this and the hind margin. Two lines cross the wing; the median, dark brown, and arising from a point a little beyond the middle of the costa, forms an outward angle very near the costa and an inward angle on the subcostal vein; then a second outward angle, formed at the end of the median vein; and from this point the line runs more or less distinctly across to the middle of the hind margin. The subterminal line, dark brown, finer, dentate, and edged on the outside with lead-colored scales, runs from the costa before the apex across to near the outer margin, thence across the wing nearly parallel with the outer margin. The space from the end of the cell to the apex somewhat stained with brown. Terminal line fine, black, and with a row of black dots. Fringes concolorous with the adjacent part of the wing, but with slight metallic reflections. Hind wings fuscous, fringes lighter.

Habitat. — Southern California. Early stages and food plant unknown.

CRAMBUS HAYTIELLUS.

Chilo Haytiellus Zinck, Germ. Mag., Vol. IV., p. 254 (1821).

Expanse of wing, 10–20 mm. Head and thorax pale ochreous yellow; palpi fuscous on the outside. Fore wings pale ochreous, with a whitish stripe from the base through the cell, and breaking up into lines on the veins outwardly. Costal portion fuscous, quite dark in some specimens. Median line represented by two or three dark-brown dots, one at the end of the cell, one on the fold and one below the fold, the three forming a nearly straight line from the end

of the cell to the basal third of the hind margin. The subterminal line, brown, edged on the outside with silvery scales, slightly serrate, forms a curve below the costa and gives off a tooth on the fold. A terminal row of black dots. Fringes silvery gray. Hind wings pale fuscous.

Habitat. — Texas, Hayti. Early stages and food plant unknown.

Crambus trichostomus. (Plate II., fig. 6.)

Crambus trichostomus Chris., Stett. Ent. Zeit., Vol. XIX., p. 313 (1858).
Crambus trichostomus Möschl., Wien. Monats., p. 379 (1860).
Crambus trichostomus Zell., Chil. et Cram., p. 28 (1863).
Crambus trichostomus Pack., Pr. Bos. Soc. Nat. Hist., Vol. XI., p. 55 (1868).

Expanse of wings, 20 mm. Head and thorax dark brown, intermingled with gray scales; palpi very hairy, dark brown, with some gray hairs above. Fore wings dark brown, with a whitish stripe from the middle of the base out to an oblique dark-brown cross stripe on the basal third; this stripe followed by a broad median white shade, extending nearly to the broad white subterminal line; this line commences on the costa a little within the apex, and, curving inward, forms an outward angle near vein 5, thence runs parallel with the outer margin to the fold, where it curves out and terminates near the anal angle. Terminal line dark brown. Lower two-thirds of the terminal space overlaid more or less with white scales. The dark portions of the wing streaked longitudinally with light and dark brown. Fringes dark fuscous. Hind wings dark fuscous; fringes paler.

Habitat. — Labrador. Early stages and food plant unknown.

Crambus oregonicus. (Plate III., fig. 9.)

Crambus oregonicus Grote, Can. Ent., Vol. XII., p. 17 (1880).
Crambus oregonicus Grote, N. Am. Ent., p. 68, Plate V., fig. 9 (1880).

Expanse of wings, 17 mm. Head and thorax white above, brown on the sides. Fore wings light ochreous brown, with a longitudinal diffuse white stripe extending across the

median space; a dark-brown, acutely dentate median line, of which sometimes only a brown dash on the median space and another at the extremity of the disk are visible. Subterminal line brown, edged with white outwardly. A white apical patch, and more or less white on the hind margin. Fringes brownish. Hind wings pale fuscous, with narrow terminal line and white fringes.

Habitat. — Oregon. Food plant and early stages unknown.

Crambus bonifatellus. (Plate VI., fig. 6.)

Spermatophthora? bonifatellus Hulst, Ent. Am., Vol. III., p. 135 (1887).

Expanse of wings, 21 mm. Head, palpi and thorax light fuscous. Fore wings yellowish fuscous, with the veins lighter; a whitish dot with a black dentate spot on each side of it near the end of the cell; an indistinct row of dark marginal points. Fringes ochreous. Hind wings smoky fuscous.

Habitat. — Colorado. Early stages and food plant unknown.

Crambus mutabilis. (Plate II., fig. 9.)

Crambus mutabilis Clem., Pr. Ph. Ac. Sci., p. 204 (1860).
Crambus fuscicostellus Zell., Chil. et Cram., p. 44 (1863).
Crambus mutabilis Felt, Grass-eating Ins, pp. 64, 83 (1894).

Expanse of wings, 23–24 mm. Palpi, head and thorax fuscous. Fore wings grayish fuscous, luteous on the posterior half; a diffuse grayish median stripe, tinted with luteous, spreading over the costal half of the wing, with the exception of a brown costal margin from the base half way to the apex; a dark-brown dot at the end of the median vein, sometimes streaked with dark fuscous below the vein. Subterminal line dark brown, faint, dentate, usually with a marginal row of brownish dots. A diffuse brown streak from the apex inward toward the cell. Fringes brownish, lustrous. Hind wings gray or pale fuscous; fringes pale fuscous.

Habitat. — Ontario, Massachusetts, Connecticut, New York, Ohio, Illinois, Kentucky, Florida, Louisiana, Nebraska, Texas. Food, grass.

"*Egg.* — Creamy white when first laid, gradually turning to an orange-rufous color before hatching. Form, elliptical oval; size, .51 mm. by .36 mm. The egg-shell has sixteen longitudinal ridges and numerous small transverse ridges.

"*Larva, First Stage.* — Head diameter, .18 mm.; body diameter, .15 mm.; length, 1.1 mm. Head pale yellowish, with a sprinkling of sooty specks; body a rather sooty, semi-transparent white, with irregular rufous blotches along the dorsum; scattered dark-colored hairs occur on the head and body." (Felt.)

Crambus hemiochrellus. (Plate II., fig. 13.)

Crambus hemiochrellus Zell., Ex. Mic., p. 49 (1877).

Expanse of wings, 22 mm. Head and thorax pale ochre-yellow; palpi thickly sprinkled with gray atoms. Fore wings bright ochreous yellow between the white median vein and hind margin, with dusty stripes, and usually a clear yellow stripe along the fold. Costal portion of the wing yellowish gray, darker towards the base. Median line fine, rust brown, forming an acute angle at the end of the cell, and extending in a nearly straight line to the middle of the hind margin. Subterminal line fine, dark brown, dentate on the veins and parallel with the outer margin except at the costal end, where it curves sharply inward and terminates at the outer fourth of the costa. Terminal space dusty gray. Terminal line rather indistinct, upon which, in some specimens, may be seen seven very fine dark-gray dots. Fringes light gray. Hind wings light gray; fringes lighter.

Habitat. — Texas. Early stages and food plant unknown.

Crambus undatus. (Plate III., fig. 12.)

Crambus undatus Grote, Can. Ent., Vol. XIII., fig. 35 (1881).

Expanse of wings, 21 mm. Palpi, head and thorax cinereous or pale grayish, dusted with fuscous. Fore wings narrow, acute, whitish gray, sprinkled with fuscous scales, especially on the basal and costal portions; two distinct, jagged, fuscous brown lines, strongly angulated above the

middle of the wing, the median quite irregular below the cell. A fine dark terminal line. Fringes pale, with metallic lustre. Hind wings pale grayish.

Habitat. — California. Early stages and food plant unknown.

Crambus trisectus. (Plate III., fig. 11.)

Carvanca trisecta Walk., Lep. Het., Vol. IX., p. 119 (1856).
Crambus exsiccatus Zell., Chil. et Cram., p. 37 (1863).
Crambus interminellus Walk., Lep. Het., Vol. XXVII., p. 156 (1863).
Crambus biliturellus Zell., Lep. Westk. Am., p. 7 (1874).
Crambus exsiccatus Grote, Can. Ent, Vol. XII., p. 78 (1880).
Crambus exsiccatus Lintn., Rep. Ins. N. Y., Vol. I., pp. 149–151 (1882).
Crambus exsiccatus Osborn, Dept. Agr., pp. 154-160 (1887).
Crambus exsiccatus Osborn, Bull. U. S. Dept. Agr., No. 30, p. 44 (1893).
Crambus exsiccatus Osborn, Ins. Life, Vol. VI., pp. 72, 78 (1893).
Crambus interminellus Felt, Grass-eating Ins., pp. 62, 83 (1894).

Expanse of wings, 23–32 mm. Palpi whitish, mixed with fuscous scales on the outside; head whitish; thorax very light ochreous. Fore wings very pale ochreous, lighter below the fold and on the outer part; surface sprinkled with dark brown; interspaces beyond the cell marked with whitish lines; a dark-brown spot near the base of vein 2, and a short, dark-brown, oblique, dentate line about half way between this and the end of the wing. Terminal line represented by three or four dark-brown dots. Fringes steel gray, cut by four or five white lines. Hind wings pale grayish white, lighter towards the base; fringes whitish.

Habitat. — Nova Scotia, Ontario, Maine, New Hampshire, Massachusetts, New York, District of Columbia, Illinois, Iowa, Nebraska, Colorado, Missouri, Vancouver Island. Food, grass.

" *Egg.* — A cream-yellow color when first laid, gradually turning to an orange-buff color before hatching. Form nearly elliptical; size, .48 by .33 mm. The egg-shell has sixteen strong longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .225 mm.; body diameter, .15 mm.; length, 1.2 mm. Head black, thoracic shield a dark brown; body a translucent white, with numerous small black tubercles, each tubercle bearing one or more light-colored hairs. Scattered light-colored hairs occur on the head. When about half grown (late fall) the larva is 2 cm. long. The head and tubercles are black, while the body is a mottled chocolate brown, with a black stripe extending along the dorsal line. Early in the spring the larva is about 3 cm. long. The head and thoracic shield are of a dark umber color; tubercles of the same color; there is a dull pinkish line along the middle of the back; there are also irregular dark wavy subdorsal and lateral lines; body a pale straw color.

"*Pupa.* — Thorax and head brown; abdomen rufous; spiracles dark brown; length about 2 cm.

"*Cocoon.* — Oval, composed of a thick layer of bits of grass, with particles of soil adhering to the outside. Inside, the cocoon is smooth and thinly lined with silk. The cocoon was made just below the surface." (Felt.)

Crambus laciniellus. (Plate IV., fig. 7.)

Crambus laciniellus Grote, Can. Ent., Vol. XII., p. 18 (1880).

Expanse of wings, 26–28 mm. Palpi pale cinereous, brownish outwardly; head and thorax cinereous. Fore wings pale cinereous ochreous, especially on the costal and outer portions of the wing; a few brown atoms sprinkled over the surface; subterminal line indistinctly marked by ochre scales partially overlaid with brown. A marginal row of three black points above the anal angle. Fringes shining fuscous, with a whitish line at the base. Hind wings pale cinereous, fringes white.

Habitat. — Maine. Food plant and early stages unknown.

Crambus dimidiatellus. (Plate IV., fig. 13.)

Crambus dimidiatellus Grote, Ann. Mag. Nat. Hist., Series V., Vol. II., p. 57 (1883).

Expanse of wings, 35 mm. Palpi ochreous, sprinkled with fuscous atoms; head and thorax pale ochreous. Fore wings with a costal band reaching to the middle of the cell, and curving up toward the apex, ashy brown, inclining to olivaceous. A white stripe extends from the base two-thirds the length of the wing, where it breaks up more or less into venular lines reaching to the outer margin. Hind margin broadly shaded with very pale ashy brown. A marginal row of black points, scarcely visible. Fringes pale ash colored. Hind wings pale silky fuscous; fringes lighter.

Habitat. — Colorado and New Mexico. Food plant and early stages unknown.

Crambus caliginosellus. (Plate IV., figs. 2, 3.)

Crambus caliginosellus Clem., Pr. Ph. Ac. Sci., p. 204 (1860).
Crambus caliginosellus Felt, Grass-eating Ins., pp. 61, 83 (1894).

Expanse of wings, 13–25. Head, palpi and thorax dark fuscous, sprinkled with gray scales. Fore wings dark fuscous, sprinkled with brown or yellowish, and frequently with a few gray scales; median line dark brown, often edged with white, arising a little beyond the middle of the costa, extending outward, forming a very acute angle, thence backward across the end of the cell to the hind margin, a little beyond the middle, and giving off an outward angle on the fold. Subterminal line dark brown, edged outwardly with dark lead-colored scales, and frequently dentate along the first part of its course. It arises from the costa about half way between the median line and the apex, extending down to a point beyond the end of the cell, where it forms an outward angle, thence to the hind margin, a little within the anal angle, giving off an inward angle on the fold. This angle is frequently connected along the fold with the outward angle of the median line; terminal line dark brown, rather indistinct. The lines are often obliterated more or less, especially the median. Fringes dark leaden gray. Hind wings dark fuscous; fringes a little lighter.

Habitat. — Ontario, Massachusetts, New York, Pennsylvania, Delaware, District of Columbia, North Carolina, Illinois, Texas. Food, grass, corn.

"*Egg.* — Creamy white when first laid, gradually turning to an orange-rufous color before hatching. Form elliptical oval, with the ends slightly truncate; size, .39 mm. by .3 mm. The egg-shell has eighteen longitudinal ridges and numerous smaller transverse ridges.

"*Larva, First Stage.* — Head diameter, .15 mm.; body diameter, .125 mm.; length, .875 mm. Color a smutty, translucent white, with irregular reddish spots on the middle line of the back; head a pale amber color. Scattered light-colored hairs occur on the head and body. Five pairs of prolegs occur on the seventh to the tenth inclusive and thirteenth segments." (Felt.)

"The full-grown larva is about one inch in length, of a slender, cylindrical form, and of a pinkish-white color, slightly tinged with brown. The head is dark brown or black. There are several stiff bristles or hairs upon each segment.

"This *Crambid* works upon the centre portion of the plant, just beneath the surface of the soil. It spins silken galleries which extend from the plant several inches just beneath the surface of the soil. Some plants were nearly girdled, and the larvæ were frequently found imbedded in cavities where they had fed upon the plants. In some instances as many as thirty larvæ were found in a single hill of corn, and in many hills the plants had been entirely destroyed." (Beckwith.)

Crambus zeëllus. (Plate IV., fig. 4.)

Crambus zeëllus Fern., Can. Ent., Vol. XVII., p. 55 (1885).
Crambus zeëllus Forbes, Rep. Ins. Ill., Vol. XIV., pp. 14, 15, Plate I, figs. 1, 2, 3 (1885).
Crambus refotalis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 166 (1886).
Crambus refotalis Fern., Ent. Am., Vol. III., p. 22 (1887).

Expanse of wings, 18–24 mm. Palpi, head and thorax pale leaden gray. Fore wings dull leaden gray, mixed with ashy and whitish, especially on the outer part, and crossed

beyond the middle by two angulated, dull ochre-yellow lines, overlaid more or less with dark brown. The first or median line crosses the end of the cell, where it is angulated. The second or subterminal, crosses the wing about half way between this last and the end. Terminal line dark brown, and a dark brownish cloud extends obliquely in from the apex to the subterminal line, but does not reach the costa. A narrow, ochre-yellow line, somewhat curved, extends from the middle of the base of the wing to the subterminal line near the anal angle, and a similar line, though less plainly marked, runs parallel between this line and the hind margin. Terminal space more or less gray. The outer margin regularly excavated below the apex. Fringes pale metallic lead color. Hind wings pale fuscous, with lighter fringes.

Habitat. — Maine, Pennsylvania, West Virginia, Illinois, Missouri. Food, corn.

The following descriptions of the larva and pupa are compiled from those published by Prof. S. A. Forbes in the "Fourteenth Report of Noxious and Beneficial Insects of Illinois," pp. 14, 15, 1895: —

Larva. — Head dark chocolate brown, slightly and irregularly rugose, with long yellowish hairs; upon the front a white S-shaped mark; cervical shield yellowish, with a white median line; anterior edge whitish, and an oval black spot on the sides. Below the lateral edges of the cervical shield are two hairy tubercles; second and third segments of thorax each with two rows of hairy tubercles, the anterior of four, the posterior of two large quadrate spaces, sometimes united in the middle. From the fourth to the tenth segment the hairy tubercles above the spiracles are in two transverse rows of four each, those of the anterior row being quadrate with rounded angles, and as large as the interspaces; those of the posterior row transversely elongated, about twice as long as wide. Lateral tubercle of anterior row immediately above the spiracle emarginate at its posterior inferior angle, on all the segments from the sixth to the ninth; on these segments a smaller tubercle behind and beneath the spiracle, and two others between the spiracle and the proleg; a narrow arcuate tubercle, with long hairs outside, in

front of each proleg. Anal shield smooth, reddish brown, with a few long brown hairs; spiracles dark brown. Ventral surface paler than the dorsal. Length of full-grown larva, .6 to .8 of an inch; greatest width, .1 inch.

Pupa. — Pupa smooth, shining, pale brown; abdomen a little darker, without hairs or spines; abdomen with an obtuse horny tip. Length, .4 inch; width, .1 inch.

CRAMBUS LUTEOLELLUS. (Plate IV., fig. 5.)

Crambus luteolellus Clem., Pr. Ph. Ac. Sci., p. 203 (1860).
Crambus duplicatus Grote, Can. Ent., Vol. XII., p. 79 (1880).
Crambus luteolellus Felt, Grass-eating Ins., pp. 61, 82 (1894).
Crambus holochrellus Zell. (Manuscript name?)

Expanse of wings, 20–26 mm. Palpi pale yellowish, dusted externally with fuscous; head and thorax ochreous yellow. Fore wings ochre-yellow, dusted more or less with ashy scales, especially outwardly; median line rather broad, yellow, very indistinct, running from the end of the cell to near the middle of the hind margin; subterminal line nearly parallel with the median, forming an outward tooth on the fold; both lines often obliterated. Terminal line very indistinct, sometimes consisting of only a row of points. Fringes concolorous with the end of wing. Hind wings fuscous; fringes much lighter.

This species is very perplexing because of its variability; some specimens before me are clear ochre-yellow, without markings of any kind, and there is every gradation between this and those with the median and subterminal lines well marked. The outer margin also varies more or less in form from straight to emarginate.

Habitat. — Ontario, Maine, New York, North Carolina, Illinois, Missouri, Colorado, Arizona, California. Food, grass.

"*Egg.* — A light rufous color when first laid. Form elliptical oval; size, .42 by .3 mm. There are about fourteen prominent longitudinal ribs and numerous smaller transverse ridges." (Felt.)

Crambus luteolellus ulæ. (Plate IV., fig. 6.)

Crambus ulœ Ckll., Ent. Mon. Mag., Vol. XXIV., p. 272 (1888).
Crambus ulœ Fern., Ent. Am., Vol. IV., p. 44 (1888).

Expanse of wings, 24 mm. This variety differs from the description above only in being a little more ashy beyond the cell. This species is so exceedingly variable that at first I was not disposed to consider this insect (the type of which Mr. Cockerell very kindly gave me) even as a variety. I have before me another specimen, from Arizona, almost identical with Mr. Cockerell's type, and another from Colorado, which is intermediate between this type and some of the eastern forms of *luteolellus*. I am now inclined to think that it may be well to consider *ulœ* a geographical variety of *luteolellus*, but perhaps more material and further study may lead me to modify even this opinion.

Habitat. — Colorado, Arizona. Early stages and food plant unknown.

I saw the type of *Crambus innotatellus* Walk. in the British Museum, but could not study the structure of it. I think it may prove to belong to the genus Chilo.

THAUMATOPSIS Morrison.

Face rounded; eyes large, hemispherical; ocelli present; antennæ scarcely more than half as long as the costa, pectinate or bipectinate in the male; labial palpi porrect, about as long as head and thorax; maxillary palpi about as long as the head, and triangularly scaled; tongue short; thorax smooth; abdomen in the male with a small anal tuft. Fore wings with twelve veins, 7, 8 and 9 from one stalk, all the rest separate; cell closed. Hind wings with eight veins, 4 and 5 arise near each other or from one point; cell open. Mr. Morrison redescribed *pexellus* Zell., and established the genus *Thaumatopsis* for it. In 1894 Mr. Grote established the genus *Propexus*, with *edonis* as the type; but, as *pexellus* and *edonis* are congeneric, we have adopted the older generic name.

Synopsis of the Species.

1.	Expanse of wings less than one inch,	2.
	Expanse of wings more than one inch,	3.
2.	Fore wings dark brown,	*striatellus.*
	Fore wings yellowish brown,	*pectinifer.*
3.	Median vein white,	4.
	Median vein not white,	5.
4.	A dark-brown streak in the outer part of the cell,	*pexellus.*
	Fore wings without dark streaks,	*magnificus.*
5.	Fore wings pale salmon pink,	*edonis.*
	Fore wings white, with numerous fine dark longitudinal lines,	*repandus.*

Thaumatopsis magnificus. (Plate IV., fig. 11.)

Propexus magnificus Fern., Can. Ent., Vol. 23, p. 30 (1891).

Expanse of wings, 40 mm. Palpi clothed with pale fawn-colored and black scales mixed; head and thorax pale fawn colored, the latter with a dorsal whitish stripe and the inner edge of the scapulæ also white. Fore wings pale fawn colored, and mixed more or less with darker scales, except on the costal region and along the fold. The costa and hind border narrowly edged with white, and the veins striped with white, the median stripe being much the widest; all are more or less expanded on the outer border. Fringes white, and cut by two parallel lines of pale fawn color. Hind wings and abdomen very pale fuscous. Fringes white.

Habitat. — Colorado. Food plants and early stages unknown.

Thaumatopsis pexellus. (Plate IV., fig. 14.)

Crambus pexellus Zell., Chil. et Cram., p. 48 (male) (1863).
Crambus macropterellus Zell., Chil. et Cram , p. 48 (female) (1863).
Thaumatopsis longipalpus Mor., Pro. Bos. Soc. N. H., Vol. XVII., p. 165 (1874).

Expanse of wings, 32 mm. Head, palpi and thorax dull ochre-yellow, intermingled more or less with gray; labial

palpi longer than the head and thorax; antennæ in the male bipectinate; fore wings with the median vein white, and bordered above with dark brown in the outer half of the cell, from which a gray shade extends to the apex, behind which the entire surface of the wings is yellowish gray, except in the fold. Fringes yellowish gray. Hind wings grayish fuscous, paler basally.

Habitat. — Georgia, Missouri, Colorado. Food plant and early stages unknown.

I have seen Zeller's type, now in the British Museum; and Morrison's type, which belongs to the National Museum, is now before me.

THAUMATOPSIS EDONIS. (Plate IV., fig. 12.)

Crambus (*Propexus*) *edonis* Grote, Can. Ent., Vol. XII., p. 19 (1880).

Expanse of wings, 34–36 mm. Head, palpi and thorax reddish fuscous; antennæ of the male bipectinate; fore wings reddish fuscous, without markings, but dusted with fuscous on the interspaces and terminally. Fringes fuscous. Hind wings pale fuscous, with paler fringes.

Habitat. — North Carolina, Kansas. Food plants and early stages unknown.

THAUMATOPSIS REPANDUS. (Plate IV., fig. 15.)

Crambus (*Propexus*) *repandus* Grote, Can. Ent., Vol. XII., p. 19 (1880).

Expanse of wings, 22–32 mm. Head, palpi and thorax whitish, more or less tinged with ashy gray. Fore wings whitish, with numerous fine dark-brown lines in the interspaces; median line broken and acutely angled at the end of the cell. Subterminal line black where it arises from the outer fourth of the costa, but soon changes to brown, forming an inward tooth on vein 7 and an outward tooth near the anal angle. Terminal line black, and broken into three dots between veins 3 and 5. Fringes silvery gray, cut with white three or four times. Hind wings pale yellowish, with white fringes and an indistinct subterminal line.

Habitat. — Texas, Arizona, Kansas, Colorado. Food plant and early stages unknown.

THAUMATOPSIS STRIATELLUS n. sp. (Plate IV., fig. 10.)

Expanse of wings, 22 mm. Head, palpi and thorax dark brown; antennæ dark brown, unipectinate. Fore wings umber brown, striped along the interspaces with dark brown. A white stripe extends from the base of the wing along the cell, near the middle of which it is broken up by a mass of dark-brown scales. Median line wanting. Subterminal line indicated by a curved line of white dots, bordered with dark brown, which extend from the outer third of the hind margin to vein 6. Terminal dark-brown dots scarcely visible. Fringes concolorous with the wing. Hind wings and abdomen slightly darker than the fore wings. Fringes a little lighter.

Habitat. — North Illinios. Described from one male specimen received from Mr. A. Bolter. Food plants and early stages unknown.

THAUMATOPSIS PECTINIFER. (Plate IV., fig. 9.)

Crambus pectinifer Zell., Exot. Mic., p. 51, Plate I., figs. 20 *a*, *b* (1877).

Expanse of wings, 19 mm. Head, palpi and thorax pale yellowish brown, sprinkled more or less with darker scales. Fore wings pale yellowish brown, darkest along the costa. A white stripe extends from the base of the wing over the cell, beyond which it breaks up into fine lines. Median line indicated by three small white spots edged with brown, in an oblique line from the end of the cell to the basal third of the hind margin. Subterminal line white, edged with brown, nearly parallel with the outer margin, and visible only below vein 5. Fringes gray, interlined with white. Hind wings pale fuscous, with lighter fringes.

Habitat. — Texas. Food plants and early stages unknown.

EUCHROMIUS GUEN.

Head medium; face with a slight cone-shaped projection; eyes hemispherical; ocelli present; antennæ about two-thirds as long as the costa, ciliate in the male, simple in the

female; labial palpi porrect, about twice as long as the head; maxillary palpi about half as long as the labial palpi; tongue well developed, scaled at the base; thorax smooth; abdomen with a medium anal tuft; legs of medium length, the inner spurs half as long as the outer.

Fore wings nearly three times as long as wide, the outer margin entire and rounded, with twelve veins all separate except 8 and 9, which are from one stalk; cell closed. Hind wings with eight veins, 4 and 5 from a stalk; cell open.

EUCHROMIUS OCELLEUS. (Plate V., figs. 13, 14)

Palparia ocellea Haw., Lep. Brit., p. 486 (1811).
Crambus Cyrilli Costa, Dizion. Univ. di Agric. (1829).
Phycis funiculella Tr., Schmett. Eur., Vol. IX., p. 200 (1832).
Araxes ocellea Steph., Ill. Br. Ent. Haust., Vol. IV., p. 316 (1834).
Phycis cirillella Costa, Faun. Napol. Phycid., p. 2, Plate V., fig. 2 (1836).
Crambus funiculellus Zell., Isis, p. 175 (1839).
Crambus funiculellus Dup., Catalogue, p. 319 (1844).
Crambus Cyrilli Zell., Isis, p. 760 (1847).
Crambus Cyrilli Herrich-Schæffer, Sch. Eur., Vol. IV., Plate XX., figs. 144, 145 (1849).
Eromene ocellea Zell., Chil. et Cram., p. 54 (1863).
Eromene Californicalis Pack., Ann. Lyc. N. H. of N. Y., Vol. X., p. 264 (1873).
Eromene texana Robs., Ann. Lyc. N. H. of N. Y., Vol. IX., p. 154, Plate I., fig. 5 (1875).
Eromene ocellea Leach, Br. Pyralids, p. 87, Plate X., fig. 2 (1886).
Euchromius ocelleus Meyrick, Br. Lep., p. 396 (1895).

Expanse of wings, 19–24 mm. Head, palpi, thorax and fore wings light brownish ochreous, the latter thickly sprinkled with dark brown; an ochre-yellow, more or less oblique band a little beyond the middle, with a narrow metallic band dividing it, and a somewhat similar oblique apical band. The terminal line consists of a row of golden metallic spots, confluent on the apical third, and preceded by a row of eight or nine black points arranged in pairs, except the second above the anal angle, which has three. These black points are on the outer border of a clear field, which is limited within by two fine gray lines, which terminate

above in the oblique apical band. Fringe concolorous with the wing. Hind wings white, more or less tinged with gray.

Habitat. — Texas, Arizona, California, southern Europe, south-western Asia, Africa, Australia, Sandwich Islands. This insect is undoubtedly a native of southern Europe, and has probably been brought to this country in comparatively recent times. The early stages and food plants are unknown. At one time I supposed that the Texas and California examples should be regarded as well-marked varieties, but upon the examination of more material I find all the usual variations among the Texan specimens and also among those from California.

ARGYRIA Hüb.

Head medium; face slightly produced; eyes large, hemispherical; ocelli present; antennæ about two-thirds as long as the costa, ciliated in the male, simple in the female; labial palpi porrect, about twice the length of the head; maxillary palpi about half as long as the labial palpi; tongue well developed, scaly at the base; thorax and abdomen smooth, the latter with an extensible anal tuft in the male; legs rather stout, outer spurs half as long as the inner ones. Fore wings about twice as long as wide, with twelve veins; 8 and 9 from one stalk, all the rest separate. Hind wings two-thirds as wide as they are long, with eight veins; 4 and 5 from one stalk; cell open.

This genus was established by Hübner, in his "Verzeichniss bekannter Schmetterlinge," p. 372, placing *nummulalis* (argentana) Hüb. and *pusillalis* Hüb. under it, and therefore *nummulalis* may be considered the type.

Synopsis of the Species.

1.	Fore wings with an oblique yellow band across the middle,	*auratella.*
	Fore wings without a yellow band, ...	2.
2.	Fore wings with yellow hind border, . . .	*argentana.*
	Fore wings without yellow hind border, ...	3.
3.	Fore wings with oblique costal marks, ...	*lacteëlla.*
	Fore wings without oblique costal marks, ...	*nivalis.*

ARGYRIA NIVALIS. (Plate V., fig. 1.)

Phalæna Pyralis nivalis Drury, Vol. III., Nat. Hist., p. 25, Plate XIV., fig. 4 (1773).
Hydrocampa (?) *nivalis* Westwood's Drury (1837).
Geometra argentata Emm., Nat. Hist. N. Y. Ag., Vol. V., Plate XL. (1854).
Urola michrochysella Walk., Lep. Het., Vol XXVII., p. 181 (1863).
Catharylla nummulalis Zell., Chil. et Cram., p. 51 (1863).
Argyria argentata Grote, Bull. Buf. Soc., Vol. II, p. 166 (1874).
Argyria nivalis Fern., N. A. Ent., p. 100 (1880).

Expanse of wings, 18–22 mm. Head, palpi, thorax and fore wings white, with a satin lustre. The outside of the palpi, the antennæ, a stripe behind the eyes, the basal edge of the costa, the terminal line and a dot near the middle of the hind margin, dark reddish brown. Fringe and anal tuft yellowish brown. Hind wings and abdomen pure white, with a silky lustre.

Habitat. — Ontario, Maine, New Hampshire, Massachusetts, New York, New Jersey, Pennsylvania, District of Columbia, Florida, Texas, Missouri, Ohio, Illinois. Food plant and early stages unknown. This comparatively common species is found in grass-lands, flying about in company with, and much like, some of the species of *Crambus*, and it is very probable that it feeds on grass.

ARGYRIA ARGENTANA. (Plate V., fig. 2.)

Tortrix argentana Martyn, Psyche, Plate XXXII., fig. 95 (1797).
Argyria nummulalis Hüb., Zutr., figs. 185, 186 (1818).
Urola subænescens Walk., Lep. Het., Vol. XXVII., p. 182 (1863).
Catharylla fuscipes Zell., Chil. et Cram., p. 51 (1863).
Argyria nummulalis Fern., N. A. Ent., p. 100 (1880).

Expanse of wings, 19–23 mm. Head, palpi, antennæ and a stripe backwards from the top of the head bright rust red; sides of the thorax and the fore wings white, with a satin lustre; the hind border orange yellow; basal edge of the costa and terminal line dark reddish brown; fringes much lighter than the terminal line; abdomen and hind wings very pale fuscous, with a silky lustre.

Habitat. — Pennsylvania, Illinois, Georgia, Florida. Food plant and early stages unknown.

Argyria auratella. (Plate V., fig. 3.)

Crambus auratellus Clem., Proc. Acad. N. Sc. Phil., p. 204 (1860).
Urola pulchella Walk., Lep. Het., Vol. XXVII., p. 183 (1863).
Catharylla pulchella Zell., Beitr., p. 95, Plate III., fig. 18 (1872).

Expanse of wings, 13–20 mm. Upper side of palpi, face and top of head, tegulæ and fore wings white, with the lustre of satin; sides of the palpi, antennæ, collar and middle of thorax above, and a band from the apical third of the costa to the middle of the hind margin, bright orange yellow. Terminal line dark red; fringe light orange yellow. Hind wings and abdomen white.

Habitat. — Maine, New Hampshire, Massachusetts, North Carolina, Florida, Illinois, California. Food plant and early stages unknown.

Argyria lacteëlla. (Plate V., figs. 4, 5 and 6.)

Tinea lacteëlla Fab., Ent. Syst., Vol. III, part II., p. 313 (1794).
Pyralis albana Fab., Ent. Syst, Sup., p. 476 (1798).
Argyria pusillalis Hüb., Zutr., figs. 167, 168 (1818).
Catharylla lusella Zell., Chil. et Cram., p. 51 (1863).
Catharylla rufisignella Zell., Beitr., p. 96 (1872).
Argyria pontiella Zell., Exotic Micr., p. 59 (1877).

Expanse of wings, 12–16 mm. Top of palpi, face, thorax and fore wings pure white, with a satin lustre; sides of palpi, top of head, collar, a dot on the middle of the costa, one on the middle of the hind margin and a more or less complete line connecting them, a preapical costal triangle divided by an oblique of the ground color and the terminal line, all dark rust red. Fringe rust yellow. Hind wings white, with a silken lustre. In one variety (Plate V., fig. 5) the median stripe of the fore wing is so far obliterated as to have only the costal, marginal and cellular spots, and in the typical *rufisignella* the cellular spot is also obliterated (Plate V., fig. 4). Fig. 6 represents a typical *pusillalis*, of which *lusella* and *pontiella* are synonyms. I have before me a long series passing by insensible grades from *rufisignella* into *lacteëlla*.

Habitat. — Florida, Texas, Jamaica, South America. Food plant and early stages unknown. All the types are still in existence, except that of *pusillalis* Hüb., but of this we have a recognizable figure. The type *lacteëlla* is in the Fabrician collection in Copenhagen, and the Zeller types are in the British Museum.

DIATRÆA Guilding.

Face with a conical projection; eyes large, sub-hemispherical; ocelli absent; antennæ about two-thirds as long as the costa, ciliate in both sexes, more strongly in the male; labial palpi porrect, about three times as long as the head; tongue rudimentary; thorax smooth; abdomen in the male with a moderate anal tuft; legs stout, of medium length, outer spurs about two-thirds as long as the inner. Fore wings, about two and one-half times as long as wide in the male, a little longer in the female, with twelve veins, 8 and 9 from a stalk, 11 and 12 coalesce for a short distance in some of the species; cell closed. Hind wings one and one-half times longer than wide, with eight veins, 4 and 5 from one point or stalked; cell closed.

Synopsis of the Species.

1.	Fore wings bluish gray, without marks or dots, . .	*idalis.*
	Fore wings yellow or brown, ...	2.
2.	Fore wings seal brown or yellowish brown, .	male *differentialis.*
	Fore wings pale ochre-yellow, ...	3.
3.	Fore wings with a terminal dark line, ...	*alleni.*
	Fore wings with terminal dots, ...	4.
4.	Expanse more than one inch and a half,	female *differentialis.*
	Expanse less than one inch and a half, . . .	*saccharalis.*

DIATRÆA SACCHARALIS. (Plate V., fig. 8.)

Phalæna saccharalis Fab., Ent. Syst., Vol. III., part 2, p. 238 (1894).
Phalæna saccharalis Fab., Skrifter af naturalist. Selak., Vol. III., part 2, p. 63, Plate VIII , fig. 1 (1894).
Diatræa sacchari Guilding, Trans. Soc. Ency. Arts, Vol. XLVI., p. 143 (1832).
Chilo obliteratellus Zell., Chil. et Cram., p. 8 (1863).
Chilo obliteratellus Zell., Ent. Zeit., Vol. XXXIII., p. 465 (1872).
Chilo obliteratellus Feld. & Rghf., Novara., Plate CXXXVII., fig. 24 (1874).
Chilo obliteratellus Zell., Exot. Microp., p. 12 (1877).
Chilo crambidoides Grote, Can Ent., Vol. XII., p. 15 (1880).
Diatræa obliteratella Zell., Col. Chil. Cram. & Phy., p. 10, Plate XI , fig. 5 (1881).
Diatræa obliteratella Com., Report Dep. Ag., p. 240 (1881).
Diatræa obliteratella Mœsch., Lep. Fauna von Port , p. 322 (1890).
Diatræa striatalis Snell., Tijds. v. Ent., Vol. XXXIV., p. 349, Plate II., figs. 1–4 (1891).

Expanse of wings, 28–38 mm. Head, palpi, antennæ, thorax and fore wings pale ochre-yellow, the latter with darker venular and intervenular lines ; one discal and seven terminal dots black. Hind wings white in the females, pale yellow in the males. All the fringes are concolorous with the adjacent part of the wings. There is a curved line of more or less distinct brown dots from within the apex across the wing, curving in towards the base of the hind margin, and also a trace of a second parallel line between this and the end of the cell. These lines of dots occur more or less distinctly in the males and also in a few females.

Habitat. — South Carolina, Georgia, Louisiana, Kansas, West Indies, South America. Food plants, corn and sugar-cane.

Egg. — The eggs are flat and circular, 1 mm. in diameter, white when first deposited, but turn yellow before hatching. They are laid early in the spring, upon the leaves of the young cane, near the axils, and, hatching in a few days, the larvæ bore their way into the stems in the immediate vicinity, and work upwards through the soft pith. The larvæ grow very rapidly, and leave their burrows occasionally to

crawl about on the outside of the stalk, and bore in again in a new place. The full-grown larva is about an inch long, rather slender, nearly cylindrical, cream white in color, and has a yellow head. When full grown it bores a hole to the surface, then retires a short distance and transforms into a slender brown pupa, about three-fourths of an inch long. In a few days the moth emerges and lays eggs for another brood, of which there are several in a season. They are supposed to hibernate in the larval stage.

The above account is compiled from the Report of the Department of Agriculture for 1880, p. 240, where remedies are given for this insect.

Diatræa alleni. (Plate V., fig. 9.)

Diatræa alleni Fern., Ent. Am., Vol. IV., p. 120 (1888).

Expanse of wings, 30 mm. Head, palpi above and middle part of the collar cream white. Outer side of the labial palpi, sides of the head and thorax and the fore wings cream buff. The hind border of the fore wings as far as vein 1, and a few longitudinal streaks beyond the brown discal spot, paler, and the whole surface of the wing evenly and sparsely sprinkled with minute brown scales; terminal line brown, fine, somewhat broken, not reaching the anal angle. Fringes whitish at the base, but darker beyond. Hind wings sordid cream color, but lighter on the basal part. Fringes lighter than the adjacent parts of the wings. Under side of the fore wings pale fuscous, with the brown terminal line reproduced.

Habitat. — Orono, Maine. Early stages and food plant unknown.

DIATRÆA DIFFERENTIALIS. (Plate VI., figs. 7 and 8.)

Diatræa differentialis Fern., Ent. Am., Vol. IV., p. 120 (1888).

Expanse of wings, 43 mm. in the males, 54–61 mm. in the females. Head, palpi, antennæ, thorax and fore wings seal brown. The top of the head and palpi, and the posterior edge of the fore wings as far as vein 1, somewhat lighter, and the fore wings sprinkled with dark scales; a small dark-brown discal spot at the end of the cell; a terminal row of seven spots of the same color, the one at the anal angle being double. Hind wings pale fuscous, lighter towards the base, which is of the same color as the abdomen. Under side of the hind wings like the upper side in color, and the under side of the fore wings a little darker; legs pale seal brown, darker in front. The female has the head, palpi, thorax and fore wings of a light brownish color, the latter sprinkled with brownish atoms. The discal and terminal spots are similar to those in the male. The remaining parts of the insect are similar to those in the male, except that the shades incline to yellowish. The difference of color between the two sexes, as shown above, is most remarkable.

Habitat. — Florida. Early stages and food plant unknown.

DIATRÆA IDALIS n. sp. (Plate VI., fig. 12.)

Expanse of wings, 25–34 mm. Head, palpi, thorax and fore wings pale mouse color, with a faint indication of an oblique row of brown dots across the end of the cell in one specimen. Hind wings pure white. Described from one female in my collection. I have a male from the National Museum, in very poor condition, which is somewhat darker, and indicates that the markings on the fore wings are more prominent. The hind wings are pale gray.

Habitat. — New Jersey, Georgia. I take pleasure in naming this interesting insect for Miss Ida J. Russell, who has rendered me most valuable assistance in my entomological work.

CHILO Zincken.

Face with a conical projection; eyes large, sub-hemispherical; ocelli present; antennæ about two-thirds as long as the costa, ciliate in the male; labial palpi porrect, nearly three times as long as the head; maxillary palpi about as long as the head, triangular, and resting on the labial palpi; tongue short; thorax smooth; abdomen in the male with a small anal tuft; legs stout, of medium length, outer spurs about two-thirds as long as the inner. Fore wings with twelve veins, 8 and 9 from one stalk, all the others separate; cell closed. Hind wings with eight veins, 4 and 5 from one point or stalked; cell closed.

Synopsis of the Species.

1.	Fore wings with metallic fringes and sprinkles, .	*plejadellus.*
	Fore wings without metallic scales, ...	2.
2.	Fore wings with veins interlined with dark, . . .	*densellus.*
	Fore wings with the veins not interlined, ...	3.
3.	Fore wings with the ground color white, . . .	*squamulellus.*
	Fore wings with ground color brown, ...	4.
4.	Hind wings dark fuscous, ...	*comptulatalis.*
	Hind wings white, fuscous apically, ...	*forbesellus.*

Chilo plejadellus. (Plate V., figs. 10, male, and 11, female.)

Chilo plejadellus Zinck., Germ. Mag., Vol. IV., p. 251 (1821).
Jartheza sabulifera Walk., Lep. Het., Vol. XXVII., p. 185 (1863).
Crambus plejadellus Zell., Chil. et Cram., p. 26 (1863).
Diphryx prolatella Grote, Bull. U. S. Geo. Sur., Vol. VI., p. 273 (1881).
Chilo oryzaeëllus Riley, Rep. Dep. Ag., p. 135, Plate VII., fig. 1 (1882).

Expanse of wings, 22–32 mm. Head, thorax and fore wings pale ochreous; labial palpi quite bushy, clothed with numerous black scales and hairs intermixed. Fore wings with numerous ferruginous scales scattered between the veins, across the end and below the cell; a series of golden metallic scales forms a subterminal line rounded and curved away from the apex; a terminal row of seven black dots. Fringes golden metallic, with metallic scales scattered over the wing. Hind wings rather paler. Female (fig. 3, *d*) much lighter in color than the male, hind wings and abdomen pure white, palpi less bushy, and with less brown scattered over the fore wings.

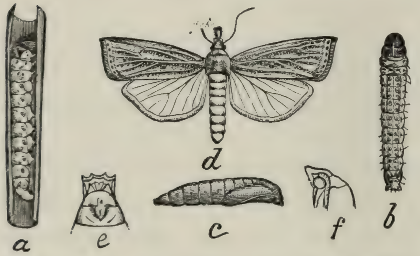

FIG. 3.— *Chilo plejadellus:* *a*, larva, side view in split stem; *b*, larva, back view; *c*, pupa; *d*, female moth, natural size; *e*, tip of pupa from beneath; *f*, head of the same, side view — enlarged. — From Department of Agriculture.

"*Larva.* — Average length, 23 mm. Head dark brown, and furnished with a few scattered brownish hairs (fig. 3, *a* and *b*). Thoracic shield light brown, median line still paler, front margin whitish; a blackish triangular spot, widening towards the lateral margin, on each side of the dorsal line. Color of the body pale yellowish white, slightly transparent, marked with four rather indistinct, pale-purplish stripes, of which those bordering the stigmata are scarcely half as broad as the others. Tubercles large, oval, pale yellowish

and polished; stigmata small, transversely oval, brown, the last pair twice as large as the others. Anal shield yellow, polished, furnished with a row of hairs upon each side and two near the middle; it is marked with a few brownish spots. Legs yellow.

"*Pupa.* — Length, 17 mm. Color, yellowish brown; head, thorax, wing-sheaths and stigmata somewhat darker; eyes black. Head bent forward, its front somewhat pointed. Thorax with very fine transverse striæ. Abdominal segments 5–7 armed dorsally near their anterior margin with numerous very minute brownish spines; all segments with extremely fine granulations. Tip of last segment rounded, with a longitudinal lateral impression; expanded dorsally into two flattened projections, each being divided into broad teeth (fig. 3, *c*, *e* and *f*)." (Riley.)

Habitat. — Pennsylvania, Georgia, Louisiana, Wisconsin. Food plants: this insect is a borer in the stems of rice, and probably of other plants.

Chilo densellus. (Plate V., fig. 7.)

Chilo densellus Zell., Col. Chil., p. 5, Plate XI., fig. 2 (1881).
Spermatophthora multilineatella Hulst, Ent. Am., Vol. III., p. 184 (1887).

Expanse of wings, 18–21 mm. Head, palpi, thorax and fore wings pale ochreous, with venular and intervenular dark ochreous lines. Discal and seven terminal dots black. Hind wings pale yellow. Females paler, with more pointed fore wings and white hind wings. All the fringes concolorous with the wings.

Habitat. — Florida, Texas, Illinois. Food plants and early stages unknown.

Chilo squamulellus. (Plate V., fig. 12.)

Chilo squamulellus Zell., Col. Chil., p. 5, Plate XI., fig. 3 (1881).

Expanse of wings, 18–21 mm. Head, palpi, thorax and fore wings white, sprinkled with brown atoms. The inner cross-line pale straw yellow, and, starting from the basal

third of the costa, extends in a straight line to the end of the cell, where it forms an acute angle and runs to the middle of the hind margin, giving off one tooth in the middle of its course. The outer line white, bordered on each side with a fine, pale, straw-yellow line, and, starting from the outer fourth of the costa, curves around to the fold, where it forms an obtuse inward angle, then runs to the hind margin. Fringe trisected by two fine black lines through it. Hind wings pure white.

Habitat. — Texas. Food plant and early stages unknown.

Chilo comptulatalis. (Plate VI., fig. 9.)

Crambus comptulatalis Hulst, Tr. Am. Ent. Soc., Vol. XIII., p. 167 (1886).

Expanse of wings, 26 mm. Head, palpi, thorax and fore wings dark umber brown, the latter with numerous black scales along the basal half of the submedian fold, broken by a light spot. Black-and-white scales scattered in the outer part of the cell, and a black discal dot surrounded by white scales. The arcuate outer cross-line half way between the cell and end of the wing, and from which indistinct dark lines extend to the terminal dark-brown dots. Hind wings and abdomen dark fuscous throughout.

Habitat. — Illinois, Missouri, Colorado, Nebraska, Vancouver Island. Food plant and early stages unknown.

Chilo forbesellus n. sp. (Plate VI., figs. 10 and 11.)

Expanse of wings, 23–38 mm. Head, palpi, thorax and fore wings dark umber brown, varying in depth of shade according to the freshness of the specimen. Fore wings with more or less white scales on the outer part of the cell, the cellular black dot in the midst of them; a similar series of white scales scattered along the submedian fold, with a black dash near the middle of the wing in the fold and another a little before it. The outer cross-line and terminal row of black dots are visible only in more or less worn specimens. Hind wings white, pale fuscous apically, with a dark-brown broken terminal line not reaching the anal

angle. First two segments of the abdomen white, remaining segments pale yellow. Female larger and lighter in color than the male, discal and terminal dots more plainly visible and hind wings lighter.

Habitat. — New York, Illinois.

There are a male and a female of this species in the National Museum, labelled "From Scirpus, D. C. Kellicot, Buffalo, N. Y." It is probable that this insect is a stem borer in Scirpus.

Named in honor of Prof. S. A. Forbes, from whom it was received, in recognition of his valuable contributions to economic entomology.

Explanation of Plate A.

ANATOMY OF CRAMBUS LAQUEATELLUS.

The original drawings for Plates A, B and C were made by Mr. R. A. COOLEY, under my direction and supervision.

Fig. 1. Side view of denuded body.
Fig. 2. Dorsal view of denuded body.
Fig. 3. Front view of head.
Fig. 4. Ventral view of head.
Fig. 5. Fore leg.
Fig. 6. Tibial epiphysis.
Fig. 7. Middle leg.
Fig. 8. Hind leg, showing the tip of one of the tibial spurs enlarged at the left.
Fig. 9. Two joints from the middle of the female antenna.
Fig. 10. Portion of a joint from male antenna, enlarged, showing sense pits, spines and reticulated surface.
Fig. 11. Portion of hind wing, showing the end of a vein, a spine (*sp*) and scale pits.
a, antenna; *c*, clypeus; *e*, eye; *l*, labrum; *m*, mandibles; *o*, ocelli; *s*, scapula; *sa*, spiny area; *mp*, maxillary palpi; *lp*, labial palpi; *pl*, prothoracic lobes; s^2, mesoscutum; s^3, metascutum; sm^2, mesoscutellum; sm^3, metascutellum; c^1, c^2, c^3, coxæ of the fore, middle and hind legs; *sp*, spine.

Explanation of Plate B.

Fig. 1. Fore wing of Crambus laqueatellus.
Fig. 2. Hind wing of Crambus laqueatellus.
Fig. 3. Fore wing of Chilo plejadellus.
Fig. 4. Hind wing of Chilo plejadellus.
Fig. 5. Fore wing of Euchromius californicalis.
Fig. 6. Hind wing of Euchromius californicalis.
Fig. 7. Fore wing of Prionapteryx achatina.
Fig. 8. Hind wing of Prionapteryx achatina.
Fig. 9. Fore wing of Eugrotea dentella.
Fig. 10. Hind wing of Eugrotea dentella.
Fig. 11. Fore wing of Crambus laqueatellus, showing the spiny area at the base and the loop of modified scales through which the frenulum passes.
Fig. 12. View from the edge of the spiny area from the fore wing of Crambus laqueatellus.
Fig. 13. Male frenulum of Crambus laqueatellus.
Fig. 14. Female frenulum of Crambus laqueatellus.
Fig. 15. Male antenna of Prionapteryx nebulifera.
Fig. 16. Male antenna of Pseudoschœnobius opalescalis.
Fig. 17. Male antenna of Crambus laqueatellus.

Plate A

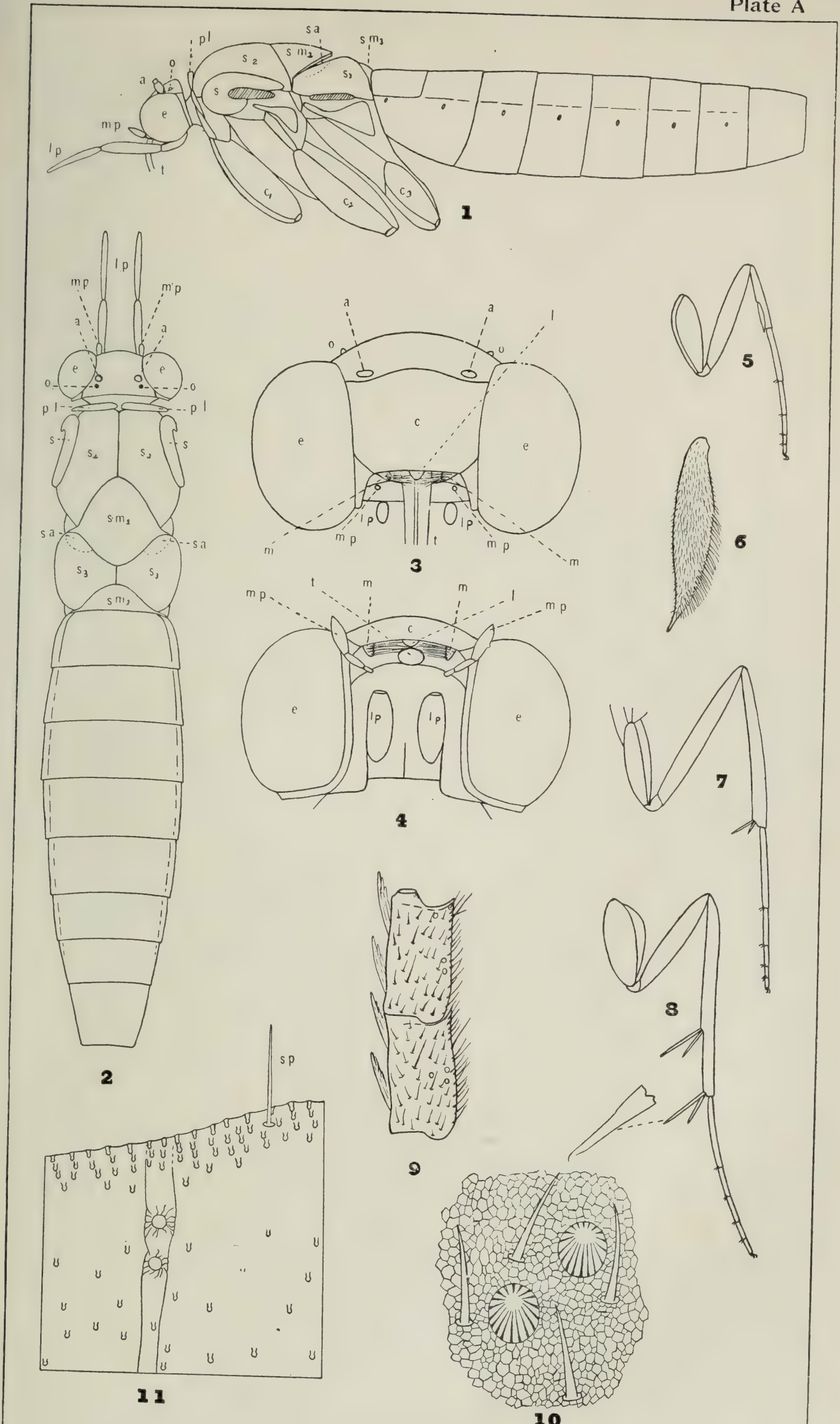

Plate B

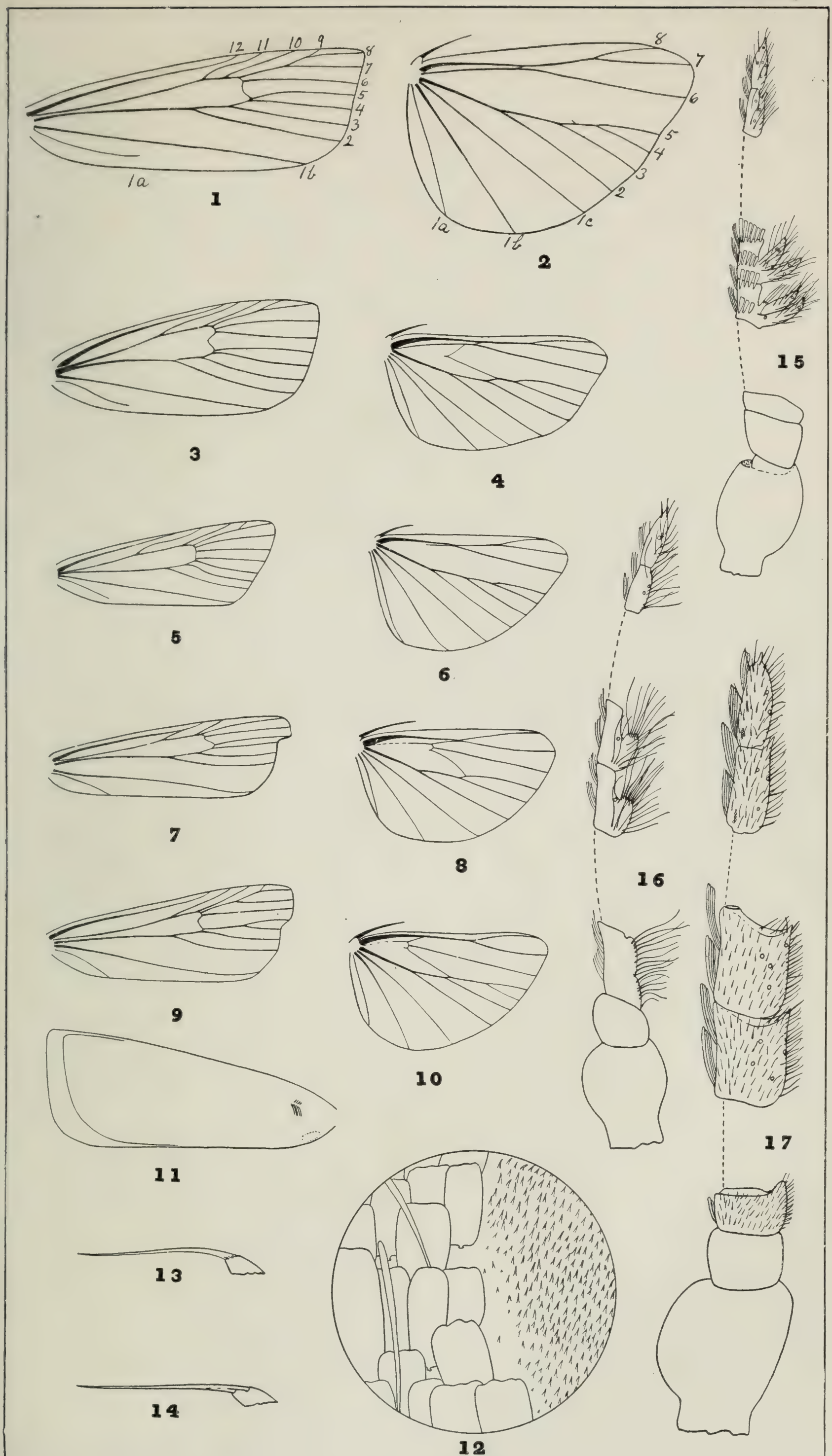
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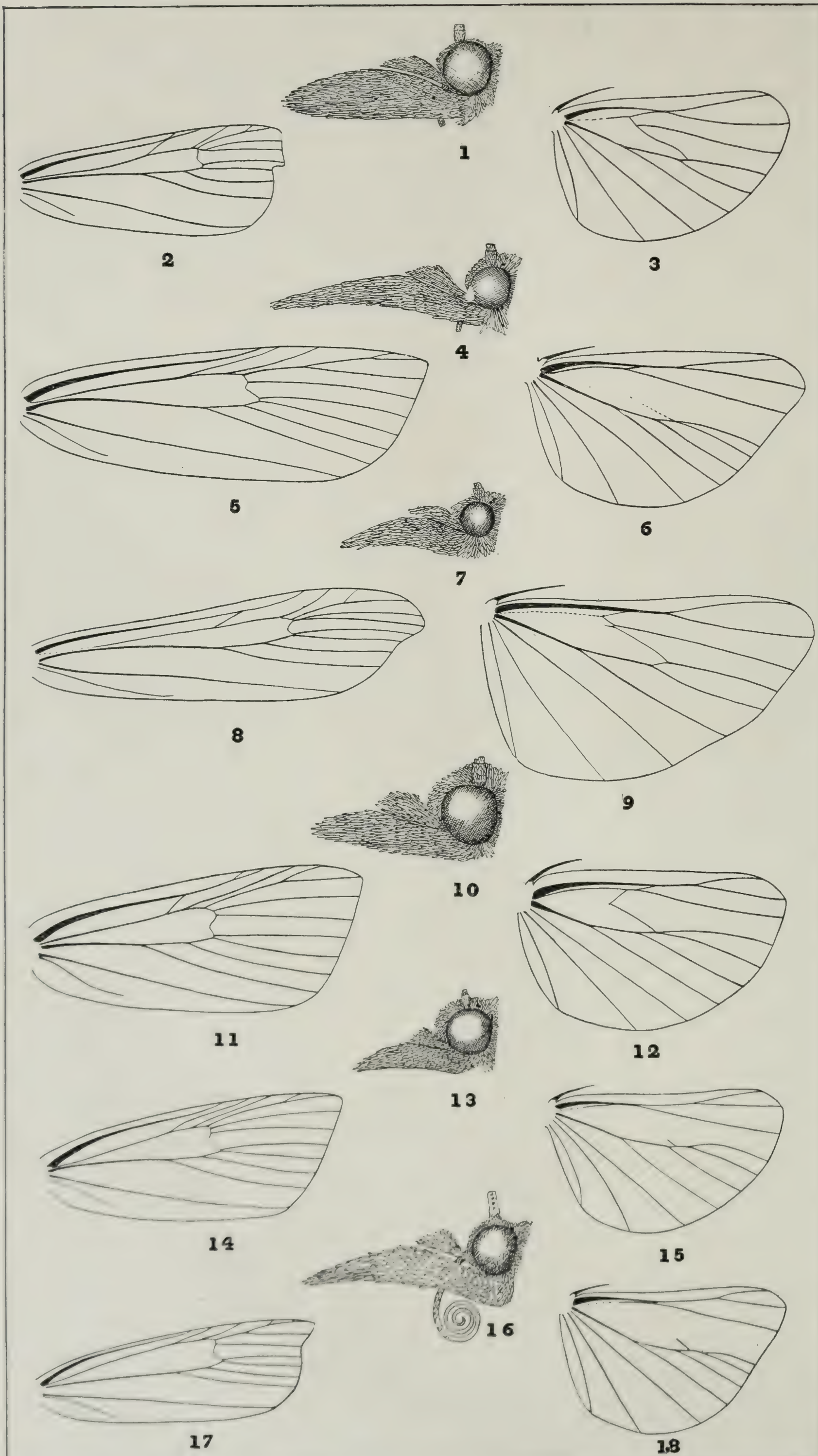
Plate C



Explanation of Plate C.

Fig. 1. Side view of head of Prionapteryx nebulifera.
Fig. 2. Fore wing of Prionapteryx nebulifera.
Fig. 3. Hind wing of Prionapteryx nebulifera.
Fig. 4. Side view of head of Thaumatopsis pexellus.
Fig. 5. Fore wing of Thaumatopsis pexellus.
Fig. 6. Hind wing of Thaumatopsis pexellus.
Fig. 7. Side view of head of Pseudoschœnobius opalescalis.
Fig. 8. Fore wing of Pseudoschœnobius opalescalis.
Fig. 9. Hind wing of Pseudoschœnobius opalescalis.
Fig. 10. Side view of head of Diatræa saccharalis.
Fig. 11. Fore wing of Diatræa saccharalis.
Fig. 12. Hind wing of Diatræa saccharalis.
Fig. 13. Side view of head of Argyria nummulalis.
Fig. 14. Fore wing of Argyria nummulalis.
Fig. 15. Hind wing of Argyria nummulalis.
Fig. 16. Side view of head of Crambus floridus.
Fig. 17. Fore wing of Crambus floridus.
Fig. 18. Hind wing of Crambus floridus.

The original drawings for the six following plates were made by Miss ELLA M. PALMER.

Explanation of Plate I.

1. Crambus satrapellus.
2. Crambus leachellus.
3. Crambus pascuellus.
4. Crambus hastiferellus.
5. Crambus carpenterellus.
6. Crambus unistriatellus.
7. Crambus præfectellus.
8. Crambus bidens.
9. Crambus alboclavellus.
10. Crambus agitatellus.
11. Crambus laqueatellus.
12. Crambus multilineëllus.
13. Crambus girardellus.
14. Crambus gausapalis.
15. Crambus decorellus.

Explanation of Plate II.

1. Crambus argillaceëllus.
2. Crambus minimellus.
3. Crambus occidentalis.
4. Crambus hamellus.
5. Crambus albilineëllus.
6. Crambus trichostomus.
7. Crambus myellus.
8. Crambus luctiferellus luctuellus.
9. Crambus mutabilis.
10. Crambus anceps.
11. Crambus hortuellus.
12. Crambus dissectus.
13. Crambus hemiochrellus.
14. Crambus ruricolellus.
15. Crambus bolterellus.

Explanation of Plate III.

1. Crambus cypridalis.
2. Crambus dumetellus.
3. Crambus hulstellus.
4. Crambus attenuatus.
5. Crambus albellus.
6. Crambus pusionellus.
7. Crambus labradoriensis.
8. Crambus coloradellus. Fore wing enlarged.
9. Crambus oregonicus.
10. Crambus teterrellus.
11. Crambus trisectus.
12. Crambus undatus.
13. Crambus turbatellus.
14. Crambus perlellus.
15. Crambus inornatellus.

Explanation of Plate IV.

1. Crambus biothanatalis.
2. Crambus caliginosellus.
3. Crambus caliginosellus.
4. Crambus zeëllus.
5. Crambus luteolellus.
6. Crambus luteolellus ulæ.
7. Crambus laciniellus.
8. Crambus elegans.
9. Thaumatopsis pectinifer.
10. Thaumatopsis striatellus.
11. Thaumatopsis magnificus.
12. Thaumatopsis edonis.
13. Crambus dimidiatellus.
14. Thaumatopsis pexellus.
15. Thaumatopsis repandus.


10


13
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11

Explanation of Plate V.

1. Argyria nivalis.
2. Argyria argentana.
3. Argyria auratella.
4. Argyria lacteëlla.
5. Argyria lacteella.
6. Argyria lacteëlla.
7. Chilo densellus.
8. Diatræa saccharalis.
9. Diatræa alleni.
10. Chilo plejadellus, male.
11. Chilo plejadellus, female.
12. Chilo squamulellus.
13. Euchromius ocelleus.
14. Euchromius ocelleus.
15. Crambus vulgivagellus.

Explanation of Plate VI.

1. Prionapteryx nebulifera.
2. Prionapteryx achatina.
3. Prionapteryx achatina.
4. Prionapteryx cuneolalis.
5. Eugrotea dentella.
6. Crambus bonifatellus.
7. Diatræa differentialis, male.
8. Diatræa differentialis, female.
9. Chilo comptulatalis.
10. Chilo forbesellus, male.
11. Chilo forbesellus, female.
12. Diatræa idalis.
13. Pseudoschœnobius opalescalis.
14. Uinta oreadella.

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EIGHTH ANNUAL REPORT

OF THE

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

JANUARY, 1896.

REPORT.

It is proper, in making this first report of the Hatch Experiment Station since its consolidation with the State Experiment Station, that its history and organization should be briefly outlined and made a matter of permanent record. The State station was established by act of the Legislature in 1882, with Prof. Charles A. Goessmann as director. Though located on the college grounds and making use of its land for purposes of experiment, it had no direct connection with it, but was governed by its own board of control. Up to the time of consolidation twelve annual reports had been issued and fifty-seven bulletins.

The Hatch Experiment Station was established under act of Congress, Public No. 112, Feb. 25, 1887. The provisions of this act were accepted by the General Court, chapter 112 of the Acts and Resolves of 1887. At a meeting of the trustees of the Massachusetts Agricultural College, held March 2, 1888, it was voted to establish another department, to be styled "The Experiment Department of the Massachusetts Agricultural College." The name was subsequently changed to the Hatch Experiment Station of the Massachusetts Agricultural College, and Pres. H. H. Goodell was elected director. Five thousand dollars of its income were annually paid over to the State Experiment Station, in consideration of its performing the chemical work required. Previous to consolidation there had been issued seven annual reports, thirty general, three special and seventy-eight meteorological bulletins.

For several years a growing feeling had manifested itself that the two stations should be united, in the interest of economy of administration, work and result.

In 1894 an act was passed by the General Court, chapter 143, to consolidate the Massachusetts Agricultural Experiment Station with the Experiment Department of the Massachusetts Agricultural College. Owing to a trifling error, the

consolidation could not be effected, and the act was amended, chapter 57 of the Acts and Resolves of 1895. The full text, as amended, is as follows: —

SECTION 1. The Massachusetts agricultural experiment station, located at the Massachusetts agricultural college in Amherst, may be transferred to and consolidated with the experiment department of the said college now known as the Hatch experiment station, in the manner hereinafter provided.

SECT. 2. The said Massachusetts agricultural experiment station, at any meeting duly called for such purpose, may, by a vote of two-thirds of the members present, authorize the transfer of all the rights, leases, contracts and property, of every kind and nature, of said station to the Massachusetts agricultural college; and the trustees of said college may, at any meeting duly called for such purpose, accept the same for said college in behalf of the Commonwealth, whereupon such transfer shall be made by suitable conveyance; and when such transfer shall be made, the said Massachusetts agricultural experiment station shall be deemed to be a part of, and to belong to, the experiment department of said college, under such name as said trustees may designate.

SECT. 3. The trustees of said college shall thereafter continue to carry on the experimental and other work for which the Massachusetts station was established, and to administer and apply all the property and funds that may be received by them hereunder, and by virtue hereof, for such purposes. They shall also from time to time print and publish bulletins containing the results of any experimental work and investigations, and distribute the same to such residents and newspapers of the Commonwealth as may apply therefor.

SECT. 4. Nothing herein contained shall operate to affect or discontinue the annual appropriations and payments thereof made and to be made by the Commonwealth for the proper maintenance of experimental work, under section six of chapter two hundred and twelve of the acts of the year eighteen hundred and eighty-two and section one of chapter three hundred and twenty-seven of the acts of the year eighteen hundred and eighty-five; and the payment of said appropriations shall hereafter be made to the treasurer of the Massachusetts agricultural college. The trustees of said college shall make or cause to be made annually to the general court a detailed report of the expenditure of all such moneys, and such further report of the annual work of the experiment department of the college station as the trustees of the college shall deem advisable.

In accordance with this action of the Legislature, at a special meeting of the trustees, held April 16, 1895, it was voted to accept, for the Massachusetts Agricultural College, the transfer of all the rights, leases, contracts and property of every kind and nature of the Massachusetts Agricultural Experiment Station to the Massachusetts Agricultural College. It was voted to consolidate the two stations, under the name of the Hatch Experiment Station of the Massachusetts Agricultural College, and the following organization was adopted: —

Henry H. Goodell, LL.D., . . .	*Director.*
William P. Brooks, B.Sc., . . .	*Agriculturist.*
George E. Stone, Ph.D., ...	*Botanist.*
Charles A. Goessmann, Ph.D., LL.D., .	*Chemist* (fertilizers.)
Joseph B. Lindsey, Ph.D., . . .	*Chemist* (foods and feeding.)
Charles H. Fernald, Ph.D., . . .	*Entomologist.*
Samuel T. Maynard, B.Sc., . . .	*Horticulturist.*
Leonard Metcalf, B.S., ...	*Meteorologist.*
Henry M. Thomson, B.Sc., . . .	*Assistant Agriculturist.*
Ralph E. Smith, B.Sc., ...	*Assistant Botanist.*
Henri D. Haskins, B.Sc., . . .	*Assistant Chemist* (fertilizers).
Robert H. Smith, B.Sc., ...	*Assistant Chemist* (fertilizers).
Charles S. Crocker, B.Sc., . . .	*Assistant Chemist* (foods and feeding).
Edward B. Holland, B.Sc., . . .	*Assistant Chemist* (foods and feeding).
Robert A. Cooley, B.Sc., . . .	*Assistant Entomologist.*
Joseph H. Putnam, B.Sc., . . .	*Assistant Horticulturist.*
George A. Billings, B.Sc., . . .	*Assistant in Foods and Feeding.*
Charles A. King, ...	*Observer.*

ANNUAL STATEMENT

OF THE HATCH FUND OF THE MASSACHUSETTS AGRICULTURAL COLLEGE FOR THE YEAR ENDING JUNE 30, 1895.

By GEORGE F. MILLS, *Treasurer pro tem.*

Cash received from United States treasurer,		$15,000 00
Cash received from agricultural department,		861 14
		$15,861 14
Cash paid for salaries,	$8,382 72	
Cash paid for labor,	1,592 88	
Cash paid for publications,	1,476 16	
Cash paid for freight and express,	103 53	
Cash paid for postage and stationery,	51 41	
Cash paid for heat, light and water,	101 90	
Cash paid for chemical supplies,	479 60	
Cash paid for seeds, plants and sundry supplies,	500 71	
Cash paid for fertilizers,	344 08	
Cash paid for feeding stuffs,	373 52	
Cash paid for library,	528 23	
Cash paid for tools, implements and machinery,	867 27	
Cash paid for furniture,	50 92	
Cash paid for scientific apparatus,	534 56	
Cash paid for travelling expenses,	195 37	
Cash paid for contingent expenses,	96 42	
Cash paid for building and repairs,	181 86	
		$15,861 14

AMHERST, MASS., Sept. 20, 1895.

I, the undersigned, duly appointed auditor, do hereby certify that I have examined the books and accounts of the Hatch Experiment Station of the Massachusetts Agricultural College for the fiscal year ending June 30, 1895; that I have found the books well kept, and the accounts correctly classified as above, and that the receipts for the time named are shown to be $15,861.14, and the corresponding disbursements $15,861.14. All the proper vouchers are on file, and have been by me examined and found to be correct, there being no balance to be accounted for in the fiscal year ending June 30, 1895.

CHARLES A. GLEASON,
Auditor.

REPORT OF THE BOTANIST.

GEORGE E. STONE.

This department of investigation was established in 1888 and continued until 1892, when, on account of Dr. Humphrey's resignation, it was temporarily discontinued. Last July the department was re-established, and the physiological laboratory is now devoted to experimental work along the lines for which it was largely designed. Owing to the fact that the laboratory and its equipment were being used in other lines of investigation to the middle of September, experimental work in botany was necessarily delayed, and it was not until October that experiments were under way. At the present time, therefore, only a brief report can be offered. It may not be out of place, however, to state concisely some of the details relating to the line of work which is being pursued, reserving a fuller account of the experiments for subsequent publications.

The work of the division falls mainly under two heads, namely, vegetable physiology and vegetable pathology. The first occupies itself with a study of plant diseases, their prevention and cure. The second deals particularly with the function of the plant, whether normal or abnormal, and is concerned with the action of such external influences as heat, light, moisture, etc. It further endeavors to ascertain how far the utilization of these external influences is responsible for the inroads of fungi, and how far the fungi can be controlled by these physiological factors.

Study of Injurious Fungi.

Throughout the entire year a large number of diseased plants is sent in for diagnosis. Work in this line must always be in progress, and the examination of these dis-

eased forms occupies considerable time. Very frequently some of the diseases prove to be new, or at least little understood, and a study of them must be made for the purpose of gaining an accurate knowledge of their characteristics and habits, and thus enable us to treat them in an intelligent manner. It is highly important that the nature of every plant disease be fully understood before any attempt is made to treat it. Any attempt at treatment not based on knowledge is as unscientific as it is impracticable. Among the apparently new diseases occupying our attention at present are bacterial diseases of the strawberry and orchid, a begonia leaf disease, a stem disease of the cultivated aster and a rust on the blackberry. Besides these, observations are being made on a number of other more or less known fungi.

In connection with the study of injurious fungi, numerous tests are being made with new fungicides, especially with solutions which can be used in the greenhouse. These tests are first made directly on the spores in the laboratory, and then the solutions are applied to susceptible or diseased plants in the greenhouse. By means of such tests the effects of the solution on the spores can be readily observed, and the strength of the solution required for spraying can be tolerably well determined.

Nematode Worms.

No class of plants is more frequently sent in during the winter than greenhouse cucumbers affected with these worms, which completely riddle the tender tissues of the roots, much to the detriment of the plants. No satisfactory remedy has as yet been found, though various experiments are now being made in the greenhouse for the purpose of relieving the market gardener from these pests.

Beneficial Fungi (Mycorhiza).

It has been known in Europe for some years that the roots of many plants are covered with fungous growths, the predominance of which — in some instances, at least — is believed to have some bearing on the absence of root

hairs. These facts, with other phenomena apparently of a similar nature which occur in the leguminosæ, etc., have led Frank * to surmise that these fungi play an important role in the assimilation of food material from the soil. As no investigations have been made to our knowledge on the occurrence of fungi on the roots of our native species of plants, Professor Smith and myself have devoted considerable attention during the past summer to work in this direction, for the purpose of determining, first, the prevalence of fungi on roots of our native plants; second, their nature and distribution; third, their relation to the absence of root hairs. Already a large number of plants have been examined, and it is proposed to carry on the investigations during the coming summer, with these additional points in view, — fourth, to prove by means of cultures whether the fungi are really essential to the plant in the assimilation of food from the soil; fifth, if proved, to throw some light, if possible, upon the process of assimilation; sixth, to ascertain whether these fungi are in any way — as Kerner maintains they are — accountable for the difficulty of transplanting certain plants.

Damping Fungi and their Relations to Temperature and Moisture.

Experiments are being made to ascertain the exact relations of the development of the damping fungi to temperature and moisture conditions. A large number of plants subject to damping off are being experimented with in a portion of the greenhouse provided with self-registering instruments. In connection with this line of work, experiments are being made to find out at what temperature the spores of injurious fungi common to the greenhouse commence to germinate. These experiments are undertaken for the purpose of learning to what extent certain diseases can be controlled by temperature and moisture conditions.

* Lehrbuch der Botanik, page 295.

General Botanical Work.

Grass Collection.

Among the specimens sent in by farmers and other citizens of the State for determination are not infrequently grasses. The station possesses already a small collection of these most important plants, and it is hoped that in the course of time a representative of every species peculiar to Massachusetts will be found here, not only for our own use in aiding identification of obscure species, but for the benefit of the student and visitor who may wish to become familiar with them.

Weed Collection.

Any one who is conversant with our ever-extending commercial relations with foreign countries can realize that a considerable number of new species of plants reaches us every year. That most of these may prove perfectly harmless there can be no doubt; but, on the other hand, we do not know but that there is in our State to-day some slumbering pest, some unnaturalized immigrant, which may in a few years become as common as the daisy or shepherd's purse, and prove as disastrous as the Russian thistle. For this reason we wish to extend our collection of State weeds, and keep a careful record of the nature and time of introduction of every species. This department, therefore, requests the co-operation of all those interested in such matters, in its endeavor to make a complete collection and accumulate data bearing on the habits of our weeds.

REPORT OF THE AGRICULTURIST.

WILLIAM P. BROOKS.

Leading Results and Conclusions based upon the Experiments outlined in the Report of the Agriculturist.

Grass and Clover.

1. Nitrate of soda applied in early spring may safely be depended upon to produce a profitable increase in the first crop of hay, but such application will not materially increase the yield of rowen. The amount to be used is from 150 to 200 pounds per acre.

2. Muriate of potash applied to land which is to be seeded to mixed grasses and clovers may be depended upon to increase the proportion of clover in the produce, and consequently to make the hay more highly nitrogenous, and particularly to increase the yield of rowen. The amount needed is about 175 to 200 pounds per acre.

3. Fertilizers for top-dressing grass lands in spring should contain nitrate of soda and muriate or sulphate of potash; and, to benefit the rowen crop, they should contain also some slower-acting forms of nitrogen, such as sulphate of ammonia, dried blood, dry ground fish, bone meal or tankage. The fish, tankage or bone meal will furnish some phosphate, of which a moderate quantity will be useful.

Corn.

1. The application of muriate of potash has so invariably increased the yield of both stover and grain that the conclusion is irresistible that potash should be more abundant in fertilizers for this crop than is usually the case.

2. There is much evidence that the fertilizer for one acre should furnish at least 80 to 100 pounds of actual potash.

3. A corn fertilizer containing 5 per cent. of potash, applied at the rate of 1,000 pounds per acre, furnishes 50 pounds of actual potash. With such a fertilizer it will pay to use from 75 to 100 pounds of muriate of potash per acre.

4. Four cords of average farm-yard manure will supply about 96 pounds of actual potash; but not all of this will be available the first year, hence it will in most cases be found profitable to use with this manure 75 to 100 pounds of muriate of potash for corn.

Rye.

This crop is most largely increased by muriate of potash and nitrate of soda, but responds much less freely to an application of fertilizers than corn.

White Mustard.

1. In this we have a crop responding most freely to an application of phosphates, indicating that the percentage of phosphoric acid in fertilizers for turnips and cabbages (members of the same family) should be large.

2. White mustard sown yearly in standing corn in the later part of July grows until late in the fall, thus preventing soluble nitrogen compounds from being washed out of the soil. It does not injure the growth of the corn the year it is sown, and the ultimate effect is to make the soil produce larger crops in subsequent years.

Potatoes.

1. Both being used in connection with materials furnishing equal amounts of nitrogen and phosphates, sulphate of potash gives larger yields of potatoes than muriate of potash.

2. Used in the same way, sulphate of potash produces potatoes of better quality than muriate of potash.

3. Potato fertilizers should therefore contain potash in the form of sulphate rather than muriate.

4. A large share of a fertilizer for potatoes should be placed in the drill. This gives larger crops of better quality than spreading broadcast.

5. Treatment with solution of corrosive sublimate of seed potatoes which are moderately scabby will prevent scab, provided the germs of this disease are not present in the soil where the potatoes are planted.

Crimson Clover.

This clover has not proved hardy here, and experiments in its use should be tried upon a small scale.

Japanese Millets.

1. The "barn-yard" variety is worth a trial. Here it has yielded per acre: (*a*) seed, 66.7 bushels, and straw, 11,297 pounds; (*b*) green fodder, 18 tons; or (*c*) hay, 6 tons.

2. The green fodder is superior to good corn fodder in feeding for milk. It makes excellent silage.

Soja Beans.

The medium green variety is a useful crop, whether for feeding green or for silage. It will yield about two-thirds as much gross weight as corn; but is far richer in flesh formers. Silage made by mixing two parts of either corn or barn-yard millet with one of the beans makes a well-balanced feed for cows.

Flat Pea.

Seed was planted in the spring of 1894, but no fodder has as yet been produced.

Sacaline.

Seed planted in the spring of 1895 germinated well, the plants made a good start and promise a large yield of fodder next year.

Hay Caps.

A trial demonstrated their great usefulness in showery weather, and indicates that the Symmes' cap has much to recommend it.

Warming a Stable for Cows.

The increase in milk and butter due to warming a stable was small, and altogether insufficient to pay the cost.

Feeding Hens for Eggs.

1. Vegetable foods, even though furnishing equal amounts of all nutrients and in the proportions considered suitable, are shown to be much inferior to animal foods furnishing the same amounts of nutrients and in the same proportions.

2. Dried meat meal, everything being considered, appears to be superior as a feed for laying fowls to cut fresh bone.

Soil Tests.

Soil tests upon the plan agreed upon in convention in Washington in 1889 have been continued. During the past season we have carried out five such tests: two upon our own grounds, one with rye and the other with grass and clover as the crops; and one each in Concord, Hadley and Shelburne, with corn as the crop. The main points indicated are as follows: —

Grass and Clover.

1. Nitrate of soda, applied at the rate of 160 pounds per acre, is beneficial to the first crop of grass, the average increase amounting to 580 pounds per acre. This result is in line with all results in previous years, both here and elsewhere.

2. This application does not appreciably increase the rowen crop.

3. The potash greatly increases the proportion of clover, and thus considerably benefits the first cut of hay, the average increase this year amounting to 569 pounds of hay for an application of 160 pounds of muriate of potash per acre.

4. The effect of the potash application is most striking upon the rowen crop. This, where timothy, red top and clover are sown, is always chiefly clover. This year there was not rowen enough to weigh except where barn-yard manure or potash had been applied.

5. The phosphoric acid has not much affected either the first or the second cutting.

I would again recommend, for mowings containing mixed grasses and clover, as follows per acre: —

	Pounds.
Nitrate of soda,	150
Tankage of dry fish,	100
Plain superphosphate,	100
Ground South Carolina rock phosphate,	100
Muriate of potash,	150

Mix just before use and spread evenly in early spring.

Corn.

The soil tests with corn this year were all upon land which has been several years under similar manurial treatment. On Mr. Frank Wheeler's farm in Concord the work was begun in 1890, and his crops in the order of succession have been corn, corn, potatoes, grass and clover, grass and clover, and corn (1895).

On Mr. Wheeler's farm this year the average yield of the five nothing plats which have received neither manure nor fertilizer since 1889 was: stover, 3,956 pounds; grain, 40.6 bushels per acre. With muriate of potash alone, at the rate of 160 pounds per acre, the yield was: stover, 2,840 pounds; grain, 59.8 bushels. The average increase on four plats where potash was used, which is apparently due to this fertilizer, is: stover, 1,257 pounds; grain, 21.6 bushels. The average gain due to the use of nitrate of soda is 3.4 bushels of grain, that due to potash (dissolved bone-black) is 2 bushels.

On Mr. West's farm in Hadley the work was begun in 1890, and the crops have been corn, corn, oats, grass and clover, grass and clover, and this year corn. The average yield of the nothing plats per acre this year was: stover, 3,584 pounds; grain, 50.7 bushels. The increase apparently due to the application of potash alone was: stover, 2,900 pounds; grain, 27.4 bushels. The average increase on all plats where potash was used, apparently due to this element, was: stover, 3,200 pounds; grain, 22.8 bushels. Similar averages for

nitrate of soda are: stover, 407 pounds; grain, 9.1 bushels. For phosphate (dissolved bone-black) there has been absolutely no average increase; the crops where this has been applied have been in fact a very little less in every instance except one where it has been used.

On the farm of Mr. Dole in Shelburne the soil test work was begun in 1889 and has continued seven years. The crops in order of succession have been corn, corn, potatoes, oats, grass and clover, grass and clover, and corn (1895). Shelburne is the only place in the State where soil test work with corn as the crop has been carried on which has not indicated potash to be most largely required. The results have been less decisive than in most places, but have indicated phosphate (dissolved bone-black) to be most useful in former years. The past season nitrate of soda appears to have been most useful to the corn crop; but there is strong reason for believing that Mr. Dole, in placing the unhusked corn in the barn, made mistakes in marking the several bunches of material; and I regret to say that the figures are such that I believe deductions therefrom would be unreliable.

Rye.

The acre upon our home grounds which has been seven years under soil test experiments has this year been in winter rye which was sown in October, 1894. In rye we have a crop with a long period of growth which is notable for its ability to extract its food from a poor soil. It was to be expected, therefore, that the differences produced by the fertilizer treatment would be less than with crops such as corn, potatoes and oats. This has been the case; but still the results speak in no uncertain tone. The succession of crops upon this acre has been corn, corn, oats, grass and clover, grass and clover, corn and rye. For the corn, the muriate of potash has been most useful; for the oats and grass, nitrate of soda; for the clover, muriate of potash. This season the average yield of the nothing plats has been: straw, 1,700 pounds; grain, 12.1 bushels. The muriate of potash alone has increased the straw 400 pounds, and the grain 4.1 bushels. On the average, the muriate of

potash has produced the following increases, viz.: straw, 800 pounds; grain, 4.5 bushels. Neither the nitrate of soda nor the phosphate has been as beneficial. The muriate of potash is most beneficial when used with both nitrate and phosphate. The plat where all three were used produced an increase of: straw, 2,480 pounds; grain, 15.4 bushels, as compared with the nothings. Where manure at the rate of five cords per acre has been applied every year for seven years similar increases are: straw, 3,200 pounds; grain, 21.1 bushels. The grain raised on the fertilizer is better than that raised on manure, and in general the size and plumpness of berry were favorably affected by potash.

What White Mustard teaches.

Soon after the rye was harvested the land was ploughed and sown to white mustard, 40 pounds of seed being put in on July 31 without additional fertilizer. The result was a striking object lesson. Germination of the seed was quick and even, but, except on the plats where manure or phosphate (dissolved bone-black), lime and plaster have been applied, there was almost absolutely no growth. On the manure and "complete" fertilizer plats growth was characterized as good; on the plats receiving respectively nitrate of soda and dissolved bone-black, dissolved bone-black and muriate of potash, and dissolved bone-black alone, it was fair. On all others it was poor, though the plats which had received lime and plaster made a little better showing than the others. It will be noticed that where for seven years we have been applying phosphate — even with nothing else — the growth of the mustard was fair to good, while elsewhere there was very little growth; the plants simply vegetated, and then stood still. This result is especially significant upon this land, for, as shown in my description of the soil test with rye, dissolved bone-black has not very materially benefited either corn, oats, grass, clover or rye. On the same land, then, we find corn, clover and rye responding most freely to potash application; oats and grass, to nitrate of soda; and mustard, — a plant of an altogether different order (the turnip and cabbage family), — to phos-

phate. It is believed this object lesson indicates that here, as in England, where the fact has long been pointed out, fertilizers for turnips especially and probably for cabbages also should be rich in available phosphoric acid.

The fertilizers applied yearly in all the soil tests alluded to in my reports are shown in the table below. In some experiments there have been five instead of four nothing plats, as shown in this table, and the numbering of the plats has been different. In other particulars the plan in all has been identical. It has for its object not the production of large crops, but the discovery of facts concerning the special requirements of crops on the soils tested.

Applied Yearly per Acre.

No.	
1.	Nitrate of soda, 160 pounds.
2.	Dissolved bone-black, 320 pounds.
3.	Nothing.
4.	Muriate of potash, 160 pounds.
5.	Lime, 160 pounds.
6.	Nothing.
7.	Farm-yard manure, 5 cords.
8.	Nitrate of soda, 160 pounds. Dissolved bone-black, 320 pounds.
9.	Nothing.
10.	Nitrate of soda, 160 pounds. Muriate of potash, 160 pounds.
11.	Dissolved bone-black, 320 pounds. Muriate of potash, 160 pounds.
12.	Nothing.
13.	Land plaster, 160 pounds.
14.	Nitrate of soda, 160 pounds. Dissolved bone-black, 320 pounds. Muriate of potash, 160 pounds.

Potato Experiments.

Objects.

1. To determine whether the muriate or the sulphate of potash should be used as a source of potash in potato fertilizers.

2. To determine whether fertilizers for this crop should be applied broadcast and harrowed in or put into the drill.

Results.

1. Eight experiments, comparing the sulphate with the muriate of potash, have given an average of 22.1 bushels of merchantable tubers per acre more where the sulphate was the source of potash.

2. The eating quality of the tubers raised when the sulphate has been the source of potash has generally been better than when the muriate was used.

3. Analyses have generally shown that the tubers raised on the sulphate have contained less water and more starch than those raised on the muriate. When this has not been the case, it is believed to have been because the tubers had not properly ripened, owing to the premature death of the tops on account of blight.

4. There has been little difference in the appearance of the tubers raised on the two fertilizers, but the advantage is slightly with the muriate in this respect.

5. The number of bushels per acre in favor of the sulphate has ranged from 4.8 to 82.5 of merchantable tubers. In only one out of the eight experiments has the muriate excelled the sulphate; the difference on total yield was then only 28 pounds per acre.

6. The fertilizer in the drill has generally given larger crops than broadcast application. This has been the case in six out of the eight experiments, the range being from 12.5 bushels to 54 bushels of merchantable tubers per acre in favor of drill application. In the two experiments where broadcast application gave the larger crops, it is believed that the fact was due to natural inequality in the soil.

Details.

These experiments were begun in 1892, and have been continued every year. Each year we have had four plats, which we will call numbers 1, 2, 3 and 4. In 1892 and 1893 these plats were one-sixth of an acre each; in 1894 and 1895, one-fourth of an acre each. The fertilizers have each year been applied broadcast to plats 1 and 2; in the open furrow before dropping the seed to plats 3 and 4. Sulphate of potash has been the source of the potash each year on plats 1 and 3, muriate of potash on plats 2 and 4. The quantities of potash salts employed have been such as to supply equal numbers of pounds of actual potash to plats which were to be compared. Fertilizers supplying equal quantities of nitrogen and phosphoric acid to all the plats have each year been applied.

The experiments of 1892 and 1893 were upon the same land. This land had been in pasture for several years up to 1889. It was ploughed and planted in 1890 and 1891, the crops being white mustard, oats, soja beans and millets. The division into plats in the potato experiments ran across the rows of the two previous years, so that previous cultural conditions had been the same on all the four potato plats. The fertilizers applied in 1890 and 1891 comprised: nitrate of soda, 160 pounds; dissolved bone-black, 320 pounds; and muriate of potash, 160 pounds, per acre in each year. The soil of these plats is a fine medium loam, underlaid by gravel at the depth of about three feet, — an excellent soil, in so far as drainage, warmth and other physical conditions go, for the potato.

The land used in 1894 and 1895 was of the same general character, but with the gravel a little farther from the surface. The same field was used both seasons. This land had, previous to 1890, been used for several years as a pasture. From 1890 to 1893 inclusive it had been used for a variety of hoed crops, all raised on fertilizers. The conditions on all four plats had been alike, but from the nature of our results it is believed that the soil in Plat 4 is inferior in fertility to that in the other plats.

The kinds and amounts of fertilizers used per acre in each of the first three years are shown below : —

FERTILIZERS.	PLATS (1892).				PLATS (1893).				PLATS (1894).			
	1	2	3	4	1	2	3	4	1	2	3	4
Nitrate of soda (pounds), .	160	160	160	160	240	240	240	240	240	240	240	240
Dry ground fish (pounds), .	200	200	200	200	300	300	300	300	-	-	-	-
Dissolved bone-black (pounds),	250	250	250	250	375	375	375	375	375	375	375	375
Sulphate of potash (pounds), .	174	-	174	-	261	-	261	-	211	-	211	-
Muriate of potash (pounds), .	-	174	-	174	-	261	-	261	-	211	-	211
Tankage (pounds), . . .	-	-	-	-	-	-	-	-	240	240	240	240
Dried blood (pounds), . .	-	-	-	-	-	-	-	-	60	60	60	60

In 1895 the same kinds and amounts of fertilizers were used on each plat as in 1894.

Manner of applying Fertilizers.

In every instance all the fertilizers to be used on a plat have been thoroughly mixed just before the seed was to be planted. On plats 1 and 2 each year all of the mixed fertilizers have been evenly spread after ploughing and at once harrowed in. On plats 3 and 4 the mixed fertilizer has been broadly scattered the full length of the open furrow in which the seed was to be dropped. In covering the seed the fertilizer was somewhat mixed with the soil and in part brought above the seed.

Seed used and Manner of Planting.

The variety of potatoes raised has every year been the same, — Beauty of Hebron. In 1892 the seed was from Aroostook County, Maine; in 1893 it was of our own raising; in 1894 all except that planted in four rows was from Maine, that in the four rows was of our own growing; and in 1895 all was from Aroostook County. In 1894 all the seed was treated with a solution of corrosive sublimate, for the prevention of scab. The treatment accomplished the object in view, and will be described later. Each year the seed has consisted of medium to large tubers, and it has been cut into pieces with two strong eyes each. It has been

planted by hand in rows three and one-half feet apart and at a distance of twelve inches in the row. Planting has always been early.

Culture and Appearance while growing.

The land has been harrowed once before the seed was up, and later the harrow or Breed's weeder has been used once or twice more. The work thereafter has been carefully and seasonably performed with one-horse cultivators and hand hoes. During the early part of each of the four seasons the crop growing where the sulphate of potash had been applied was distinctly more vigorous and of a deeper color than that growing on the muriate. This difference was maintained throughout the season, but became less noticeable towards the close of the season of growth.

A similar difference in favor of drill application was always observed, also somewhat less marked towards the close of the season.

The crops of 1892 and 1893 were not affected by leaf blight to any great extent; but those of both 1894 and 1895 were affected, and as a consequence the tubers were less perfectly matured in those years.

Yields per Acre (Bushels).

Sulphate of Potash.

1892.	Broadcast, merchantable tubers, 185.7; small tubers, 10.8.
	Drill, merchantable tubers, 192.5; small tubers, 13.5.
1893.	Broadcast, merchantable tubers, 290.4; small tubers, 26.4.
	Drill, merchantable tubers, 344.4; small tubers, 15.0.
1894.	Broadcast, merchantable tubers, 248.0; small tubers, 20.0.
	Drill, merchantable tubers, 268.4; small tubers, 17.2.
1895.	Broadcast, merchantable tubers, 241.5; small tubers, 15.3.
	Drill, merchantable tubers, 260.4; small tubers, 14.0.

Muriate of Potash.

1892.	Broadcast, merchantable tubers, 166.6; small tubers, 13.3.
	Drill, merchantable tubers, 179.0; small tubers, 17.0.
1893.	Broadcast, merchantable tubers, 285.6; small tubers, 15.0.
	Drill, merchantable tubers, 325.6; small tubers, 21.0.
1894.	Broadcast, merchantable tubers, 254.4; small tubers, 14.3.
	Drill, merchantable tubers, 186.4; small tubers, 11.3.
1895.	Broadcast, merchantable tubers, 234.0; small tubers, 16.6.
	Drill, merchantable tubers, 222.7; small tubers, 13.5.

An examination of the figures for corresponding years and plats reveals the fact that the plats receiving sulphate of potash have given the largest yield in every instance except one, viz., broadcast application in 1894. The averages for the two potash salts are as follows: sulphate of potash, per acre, merchantable tubers, 253.9 bushels; small tubers, 16.5 bushels; muriate of potash, per acre, merchantable tubers, 231.8 bushels; small tubers, 15.25 bushels. The average difference amounts to 22.1 bushels of merchantable tubers and 1.25 bushels of small tubers. The difference in cost between the two potash manures amounts to about two dollars per year, the sulphate costing the more.

It should be remarked that since some adverse influence, previously alluded to (not connected with the system of manuring), has affected the crops upon Plat 4 during 1894 and 1895 (drill application of muriate of potash), the above average difference in favor of the sulphate of potash is undoubtedly too large. If we leave this plat out of the calculation, the average difference in favor of the sulphate of potash amounts per acre to merchantable tubers, 13 bushels; small tubers, .3 bushels.

Comparison of the yields on plats receiving the same fertilizers in the different years shows that drill application has given the larger yield in all cases except where drill application of the muriate of potash is compared with broadcast application for 1894 and 1895. As previously stated, Plat 4 (muriate of potash in the drill) has evidently suffered from some inherent inequality in conditions. It therefore seems best to disregard the results of muriate of potash for the seasons 1894 and 1895 in estimating the relative merits of the two systems of application. On this basis the average difference in favor of drill application amounts per acre to 23.5 bushels of merchantable tubers.

Quality of the Crops.

In each year, soon after digging, samples of potatoes grown respectively on sulphate and muriate of potash have been sent under numbers with no other information to several families, who were requested to use them and report whether there was any difference in quality. In 1892 all

reported that the potatoes grown on the sulphate were whiter, more mealy and better flavored than the others. In 1893 they all reported that they could see no great difference between them. In 1894 and 1895 the potatoes grown upon the sulphate were with one or two exceptions reported to be superior to those grown on the muriate, in color, mealiness and flavor. Those reporting otherwise stated that they could see no great difference. In 1894 the head of one family said: "If you have potatoes like No. 1 [grown on sulphate] I would like to get my winter's supply of you; but I would not take No. 2." The season of 1893 was exceptionally hot and dry, as was also that of 1894; but the soil used in 1894 was deeper, and the crop suffered comparatively little from drought.

Moisture and starch determinations in samples of potatoes grown respectively on the sulphate and the muriate have been made every season. The results are shown below for the first three years. They are not given for the present season, because but two samples were taken: one the muriate potatoes, where the fertilizers were put on broadcast; the other the sulphate potatoes, where the fertilizers were put in the drill.

		Sulphate of Potash Potatoes.		Muriate of Potash Potatoes.	
		Water (Per Cent.).	Starch (Per Cent.).	Water (Per Cent.).	Starch (Per Cent.).
1892	Broadcast, ...	81.09	10.66	81.33	11.99
	Drill, ...	81.56	10.98	81.83	9.45
1893	Broadcast, ...	75.56	16.98	81.99	12.52
	Drill, ...	74.40	18.44	78.98	14.11
1894	Broadcast, ...	78.01	15.98	77.53	16.03
	Drill, ...	78.18	15.75	77.68	16.28

It will be noticed that in three out of the six possible comparisons the percentage of water is less and that of starch is greater in the potatoes grown on the sulphate of potash, and that the differences are considerable. In those cases where the results were favorable to the muriate, the differences as a rule are small. The averages for the two fertilizers are: sulphate of potash potatoes, water, 78.11 per cent.; starch,

14.99 per cent. Muriate of potash potatoes, water, 79.86 per cent.; starch, 13.68 per cent.

In those seasons when the muriate potatoes have compared most favorably with the sulphate potatoes, the crop has suffered from leaf blight, and has not therefore ripened as well as in other seasons. It is believed that the experiments indicate that, under average conditions of soil, season and ripening, the potatoes grown on the sulphate of potash will contain less water and more starch than those grown on the muriate.

Examination of the above table shows also that the potatoes grown under drill application of the fertilizers have usually been superior in quality to those grown where the fertilizers have been put on broadcast, containing less water and more starch. The most marked exception is on muriate of potash in 1892; but it appears not unlikely that there was an error in the analysis, since the proportion of water in the drill potatoes is nearly the same as in those grown where the fertilizers were broadcast. It will be noticed that elsewhere the variations in water and starch are about equal in amount, but in opposite directions. When there is more water there is less starch, and *vice versa*. Leaving out the muriate plats for 1892, the averages are: for drill application of fertilizers, water, 78.2 per cent.; starch, 14.9 per cent. Broadcast application of fertilizers, water, 78.8 per cent.; starch, 14.4 per cent.

It is undoubtedly the better ripened condition of the tubers raised under drill application which accounts for their superiority.

Maine compared with Home-grown Seed.

In 1894 Houlton seed in quantity supposed to be sufficient for the entire area under experiment was obtained. It proved insufficient, and the last four rows in each of the four plats were planted with seed grown upon the farm the previous year. These potatoes were raised from Houlton seed. The season of 1894 was, therefore, the first removed from the Maine stock. The results were decidedly in favor of the Houlton seed. The plants started quicker and more vig-

orously, and maintained their superiority throughout the entire season. At harvest the superiority of the crop from the Houlton seed was marked. Each kind was separately weighed on each plat. On Plat 1, Maine seed yielded at the rate of 399.5 pounds more than home seed; on Plat 2, 454 pounds more; on Plat 3, 605.5 pounds more; on Plat 4, 548 pounds more. Per acre the difference in favor of Maine seed amounted to 36.5 bushels, — far more than enough to repay the usual difference in the cost of the two kinds of seed.

Treatment of Seed with Corrosive Sublimate.

In 1894, as the seed to be used showed a little scab, it was all treated with corrosive sublimate solution. Two and one-fourth ounces of corrosive sublimate were dissolved in fifteen gallons of water. The seed was at first washed with a hose, being spread in a shallow inclined trough. After draining, the seed was put into the solution and allowed to remain one and one-half hours. It was then taken out, spread and allowed to dry in the sun, being cut and planted about as soon as it was dry. Corrosive sublimate can be purchased of druggists. It is a dangerous poison if taken into the stomach, but it is not at all dangerous to handle the seed thus prepared. The same solution can be used several times if all the seed cannot be put in at once. Care should be taken to use wooden vessels for the solution, as it will corrode metals. After use the solution should be thrown away in such a manner as to make it certain that animals cannot get hold of it, and where it cannot contaminate wells, springs, streams or ponds.

The treatment is effective in preventing scab where the germs of the disease are not present in the soil, — *i. e.*, on land where scabby potatoes have not been grown for several years. The method was perfected by Professor Bolley of North Dakota, and is fully described in Bulletin No. 9 of that station.

Variety Tests of Potatoes.

Sixty-five varieties of potatoes have been grown during the past season. With few exceptions we procured three pounds of seed of each variety. This seed came from many different sources and was of very varied quality and excellence, both as regards original characteristics and conditions as affected by keeping and transportation. It is not believed that with seed of the different varieties of such unlike character it is possible to make comparisons of permanent value between the varieties. We now have a supply of seed of each sort raised by ourselves under precisely the same conditions. It will be kept and managed alike for all varieties. With such seed to start with, and planted under appropriate conditions, we shall obtain results of value for purposes of comparison.

Meanwhile the following details will be of interest, as illustrating to what an extent the crop is influenced by the seed. The seed of all varieties was cut into pieces of two eyes each, with a very few exceptions where this would have made the pieces extremely small. One row of each sort was planted. Its length was forty feet, the pieces being placed twelve inches apart in the row. The distance between the rows was uniform, three and one-half feet. With the exception of two or three sorts which arrived late, all kinds were planted on the same day. The tops of all were prematurely killed by the blight due to *Macrosporium*, and at about the same time. Full notes have been put on record regarding peculiarities in growth, and the character of the crop harvested. The yield of each has been recorded, — it varies from $24\frac{1}{2}$ to $71\frac{1}{4}$ pounds merchantable potatoes. Six varieties gave a total yield of more than 60 pounds, twenty-three varieties between 50 and 60 pounds, seventeen varieties between 40 and 50 pounds and sixteen varieties between 30 and 40 pounds. The balance gave under 30 pounds total yield. A yield of 60 pounds is equivalent to about 315 bushels per acre. The best variety, then, yielded at the rate of about 368 bushels of merchantable tubers per acre, the poorest at the rate of about 125 bushels.

The soil was a medium, well-drained loam. It received a

dressing of manure in December, 1894, at the rate of 7 cords per acre. We used fertilizers, mixed and applied in the drill at the following rates per acre: —

	Pounds.
Nitrate of soda,	120
Dissolved bone-black,	187½
Sulphate of potash (high grade),	105½
Tankage,	120
Dried blood,	30

Manure alone *v.* Manure and Potash for Corn.

The experiment to test the value of manure and potash as compared with a larger quantity of manures alone for the corn crop has been continued, the past being the fifth successive year of similar treatment. Where manure alone was used we applied at the rate of 6 cords per acre, spread after ploughing and harrowed in. The manure and potash similarly applied have been put on at the rate of 4 cords of the former and 160 pounds of muriate of potash for the latter. The plats, four in number, contain one-quarter of an acre each. The results are shown below: —

Plat No. 1, manure, stover, 1,367 pounds; corn on the ear, 1,227 pounds.
Plat No. 2, manure and potash, stover, 1,223 pounds; corn on the ear, 1,065 pounds.
Plat No. 3, manure, stover, 1,025 pounds; corn on the ear, 1,266 pounds.
Plat No. 4, manure and potash, stover, 987 pounds; corn on the ear, 1,160 pounds.

The manure used was made by cows, that applied to Plat 4 being not as good as that applied to the other plats.

The application made furnished plant food at the following rates per acre: —

FERTILIZERS.	Nitrogen (Pounds).	Phosphoric Acid (Pounds).	Potash (Pounds).
Plat 1, manure alone,	126.4	99.9	232.2
Plat 2, manure and potash,	96.2	67.5	260.8
Plat 3, manure alone,	109.1	100.3	217.8
Plat 4, manure and potash,	83.8	90.4	224.6

It will be noticed that where manure alone was applied considerably more nitrogen and phosphoric acid have been supplied than on the other plats, while the quantity of pot-

ash also is large. It will not be wondered at that after five years of such treatment these manure plats are yielding larger crops than those receiving smaller amounts of manure and potash. The average difference in favor of the manure alone this year is at the rate of 6.8 bushels of grain and 364 pounds of stover per acre, — not enough to cover the larger cost of the manure, as compared with the cost of the lesser amount of manure and the potash. The crop per acre is worth this year $4.17 more when manure alone was applied; but the 6 cords of manure must be reckoned as costing $6.80 more than the 4 cords of manure and the 160 pounds of muriate of potash.

Special Corn Fertilizer *v.* Fertilizer containing More Potash.

Many soil tests in different parts of the State having indicated that fertilizers for corn should contain a larger proportion of potash, an experiment in continuous corn culture was begun in 1891. There are four plats of one-fourth of an acre each, on two of which the "special" furnishes the amounts of nitrogen, phosphoric acid and potash that would be supplied by the application of 1,200 pounds of a fertilizer having the average composition of all leading kinds offered in our markets in 1891.

The materials used are shown below: —

FERTILIZERS.	Plats 1 and 3 (Pounds).	Plats 2 and 4 (Pounds).
Nitrate of soda,	55½	33
Dissolved bone-black,	213	112½
Muriate of potash,	27	75

The yields the past year are shown below: —

Plat 1, "special" fertilizer, stover, 1,092 pounds; grain on ear, 1,112 pounds.

Plat 2, fertilizer richer in potash, stover, 1,199 pounds; grain on ear, 1,055 pounds.

Plat 3, "special" fertilizer, stover, 958 pounds; grain on ear, 1,220 pounds.

Plat 4, fertilizer richer in potash, stover, 1,100 pounds; grain on ear, 1,190 pounds.

Computed to the acre and the grain in bushels, the averages are: "special," stover, 4,100 pounds; grain, 58.3 bushels; fertilizer richer in potash, stover, 4,598 pounds; grain, 56.1 bushels. Here, as in the comparison between "manure" and "manure and potash," there is rather more stover and a little less grain where the greater amount of potash is used. The "special" produces this year, per acre, 2.2 bushels more grain and 498 pounds less stover than the combination with more potash. The increase in stover due to the greater amount of potash is worth about $1.10 more than the increase in grain due to the "special;" hence, as the fertilizer richer in potash costs about $2.52 less per acre than the special, there is a net advantage amounting to $3.62 per acre in favor of the former.

It is believed that by *the introduction of plants of the clover family* (*nitrogen traps*), which from experiments here and in many other places we are justified in concluding would grow more luxuriantly where the larger amount of potash has been used than where "special" has been applied, the advantage of the larger potash application could be much increased. An effort to demonstrate this fact has been made in each of the seasons of 1893 and 1894 by sowing *crimson clover* on one-half of this acre; but, owing to the *winter-killing* of this *clover* both years, the effect, though favorable, is small. Per acre the yields have been: where crimson clover was sown, stover, 4,512 pounds; grain, 58.6 bushels; without clover, stover, 4,186 pounds; grain, 55.9 bushels. The clover has been sown in the standing corn in July, and turned under just before planting the corn the following spring.

Hill *v.* Drill Culture for Corn.

On plats 1 and 2 in both the corn experiments just described the corn was planted in drills; on plats 3 and 4, in hills. We have left equal numbers of plants to a plot in both systems. All rows were three and one-half feet apart; hills with three plants each, three feet apart; plants in the drill one foot apart. In both experiments the hill system has produced rather more grain and less stover than the drill. The average figures per acre are as follows: manure

v. manure and potash, hills, stover, 4,024 pounds; grain, 60.7 bushels; drills, stover, 5,180 pounds; grain, 57.3 bushels; "special" *v.* fertilizer richer in potash, hills, stover, 4,116 pounds; grain, 60.3 bushels; drills, stover, 4,582 pounds; grain, 54.2 bushels. Averaging both experiments, the drill system produced the more valuable *total* crop.

White mustard as a crop for nitrogen conservation has been sown on one-half of the acre of corn where *manure alone* is compared with *manure and potash* every year since 1892. The mustard seed is sown in the standing corn in July, at the rate of 24 pounds per acre. Its growth from year to year has varied greatly, as in very dry seasons it does not start well. The past two seasons the growth has been light. It is ploughed in late in the fall. The beneficial effect is apparent, and is doubtless largely due to the fact that the mustard, which grows till very late in the season, prevents in a measure the loss of soluble nitrogen compounds by leaching. It acts as a *nitrogen conserver.* The averages this year per acre are as follows: with white mustard as a green manure, stover, 4,828 pounds; grain, 61.7 bushels; without the mustard, stover, 4,376 pounds; grain, 56.3 bushels. *Gain by green manuring*, stover, 452 pounds; grain, 5.4 bushels.

Japanese Millets.

Panicum crus-galli.

The Japanese millet of this species, which I propose to call "barn-yard" millet, because it is of the same species as the common barn-yard grass, has been very thoroughly tried the past year, for seed, for green fodder and for hay.

For Seed. — For seed purposes we raised about three-quarters of an acre. The land, in very moderate fertility, was manured at the rate of 6 cords per acre of good manure in December, 1894, and after ploughing this spring the following materials per acre were spread on (mixed) and harrowed in: nitrate of soda, 100 pounds; dissolved bone-black, 200 pounds; and muriate of potash, 100 pounds. The seed was put in with a small seed sower, in drills fifteen inches apart. It was wheel-hoed, and kept free from weeds. The

crop was very even, averaging seven feet in height. The yield was at the rate per acre: straw, 11,297 pounds; and seed, 66.7 bushels.

For Green Fodder and the Silo. — Several pieces of an acre or more each were sown for feeding green or for the silo. The earliest, sown broadcast about the middle of May on rich land, one peck of seed to the acre, averaged about six feet in height and produced over 15 tons per acre. This was cut from day to day, beginning before the millet had blossomed. Another field of about an acre, sown the last of June, yielded at the rate of rather over 18 tons per acre. Another field, sown July 26, after a crop of hay was removed, yielded about 12 tons per acre. The crop of the two last fields was put into the silo. That cut from day to day and fed green to cows was much relished. Its superiority to well-eared flint corn fodder was very apparent. Cows with both before them always take the millet first; they consume it without waste, while they are apt to leave a part of the stalks of the corn as it approaches maturity. In alternating this feed with corn fodder, the cows invariably increased in milk when put upon the millet and fell off when changed to corn.

It has been ensiled with soja beans, — about two parts by weight of the millet and one of the beans. This combination makes very superior silage.

For Hay. — A more extensive trial of this millet for hay has been carried out this year than ever before. It is coarse and difficult to dry. I have always felt that these qualities would render it undesirable as a crop for hay. We have, however, cured it successfully this year, mostly in small cocks, as clover is often cured; and the result is encouraging. The hay is coarse, but is freely eaten by horses, being preferred to a good sample of timothy, red top and clover mixture. The yield of the millet is very large, having on good land amounted to 6 tons per acre of well-cured hay. It will produce a fair second cutting if sown early in May and cut when in blossom.

The soil best for this millet is one that is rather retentive and rich. It stands up remarkably well, notwithstanding its great height. From a peck to a half bushel of seed, accord-

ing to the richness of the land and the season of sowing, is enough. Less seed the richer the land and the earlier the season should be the rule. This millet will not endure drought well, except it be sown early in retentive soil. From early corn-planting time to about July 1 will usually be the limits of season for profitable sowing.

Panicum miliaceum.

This species, some other varieties of which are known as "panicle," "broom-corn" and "French" millets, I shall speak of hereafter as "Japanese panicle" millet. It has been grown upon a small scale for seed the past year. The area was a little less than a quarter of an acre. It received at the rate per acre: nitrate of soda, 175 pounds; dissolved bone-black, 320 pounds; and muriate of potash, 175 pounds, — all mixed, sown broadcast and harrowed in. The seed was thinly sown in drills, fifteen inches apart, and cultivated and kept free from weeds. The yield was at the rate of: straw, 5,856 pounds; seed, 34.1 bushels per acre. This variety is liked for fodder by some who have tried it; but I regard it as inferior to the barn-yard millet for that purpose. The seed is valuable for poultry and birds.

Panicum italicum.

The Japanese variety of this species has been grown for seed; soil, manure and fertilizers, as well as manner of planting and care, the same as for "barn-yard" millet. It yields at the rate per acre: straw, 3,836 pounds; seed, 66.4 bushels. This variety is of value for fodder, but I prefer the "barn-yard" variety.

Variety Tests with Millets.

Twenty-seven varieties of millet have been grown upon a small scale, for purposes of comparison. With three exceptions four rows, each thirty feet long, were planted. Of these, owing to our inability to procure enough seed, we had but one or two rows. Careful observations have been put on record, but only for preliminary purposes, as the scale of work was small. The gross yield varied from 11 to 49

pounds. Six varieties yielded above 40 pounds; six, from 30 to 40; seven, from 20 to 30; and eight, between 10 and 20 pounds. Four varieties, "White French," "broom corn," "hog" and "California," appear to be identical. The "pearl" millets are too late to perfect seed here. The Japanese (*italicum*) excelled either the "golden" or the "golden wonder."

Variety Tests with Turnips.

Preliminary tests have been made with thirty-two varieties of turnips. There were among the number numerous kinds which appear to differ from others only in name, and there was a wide difference in yield and quality. Further work must be done before reporting details.

Soja Beans.

Early White. — Grown for seed; area, .49 acre; yield, 18¼ bushels per acre. This variety is too small for fodder. It ripens as surely here as our common field corn. The beans ground are slightly superior in feeding value, for milk, cream or butter, to cotton-seed meal, but the yield is rather small. The cultivation costs about the same as that of corn for equal areas. The vines shed their leaves before the pods are ripe, and hence they have very little feed value. The manurial value of the straw is about $2.40 per ton.

Medium Black. — This variety, though later than the above, has ripened here every year for the last seven. It has been grown this year both for seed and for the silo. For seed: area, .6 acre; yield, 14 bushels per acre. This variety rusted somewhat this year. We put the product of .45 acre into the silo, mixed with about two parts by weight of barn-yard millet. The yield was at the rate of 12,922 pounds per acre. This crop stood about three and one-half feet high. It is better for fodder than the early white, but appears to be much inferior to the medium green variety for that use.

Medium Green. — This variety is a little later than the last. It has ripened every year until this without injury.

This year it was somewhat injured by frost; but we have nevertheless secured a very good crop of seed. Area for this purpose, .6 acre; yield, 14 bushels per acre. We put the product of .45 acre into the silo with millet, as just described. The crop averaged nearly four feet in height, and was heavily podded. The yield was 20,644 pounds per acre. I look upon this as a very valuable fodder variety, either for feeding green or for the silo. It is a rich nitrogenous feed, and (of great importance) it can take much of its nitrogen from the air. Its roots here are very thickly covered with tubercles containing the bacilli which give it this power. For comparison, I give figures showing the analysis of this bean fodder and those for corn fodder: —

	Per Cent.
Medium green soja bean, pods formed, but not hardened, dry matter,	30.16
Longfellow corn fodder, ears glazed, dry matter, ...	27.81

Composition of Dry Matter (Per Cent.).

	Protein.	Fat.	Cellulose.	Carbo-hydrates.
Medium green soja bean, . .	19.35	3.87	23.51	40.30
Longfellow corn fodder, . .	9.79	3.26	18.27	63.11

The protein is classed as a flesh former, the other substances above named are fat and heat producers. The flesh formers and the fat of fodder are the most valuable of these constituents, pound for pound; the cellulose or fibre is the least valuable. On the farm here our average yield of corn fodder is about 16 tons per acre, while the green soja bean gave this year a little over 10 tons. The amounts of the different food constituents produced are as shown below: —

Food Constituents per Acre (Pounds).

	Flesh Formers.	Crude Fat.	Fibre.	Fat and Heat Producers.
Green soja bean, ...	1,167.2	233.4	1,418.1	2,430.9
Longfellow corn, ...	871.3	290.1	1,626.0	5,616.8

It will be noticed that the bean produces about 300 pounds more flesh formers than the corn, but that the latter gives us over 3,000 pounds more fat and heat producers. These consist chiefly of starch and sugar, both of which are easily digested and valuable foods. The differences in crude fat and in fibre are much smaller, but the balance is slightly with the corn. There can be no doubt, then, that the latter produces the more valuable crop of the two, and the cost of production for equal areas does not differ very materially. In three respects, however, the bean is superior to the corn; viz., (1) it can draw much of its nitrogen from the air; (2) the bean stubble and roots probably have greater manurial value than those of corn; and (3) the bean, being so rich in flesh formers, may take the place of such concentrated foods as cotton-seed meal, linseed meal, gluten meal, etc.

Silage made from either barn-yard millet or corn and medium green soja bean, in the proportion by weight of about two parts of either of the two former to one of the latter, makes a perfectly balanced ration for milch cows, without grain or other feed of any kind. It is not believed that it would be advisable to feed altogether upon this material, for cows like variety, and it is possible that continuous use of a fermented feed like silage would have a prejudicial influence upon health. A combination of such silage and clover hay or clover rowen — about two parts of the silage to one of the hay by weight — would, I believe, give good returns in milk. This particular system of feeding has not yet been tried here.

Miscellaneous Crops.

We have had under trial a number of miscellaneous crops, including *Cystisus proliferous albus*, a new fodder plant sent on for trial by J. M. Thorburn & Co.; yellow millo maize, from the United States Department of Agriculture; two varieties of dent corn, from South Dakota; black barley; spring wheat, from South Dakota; horse bean; sacaline; flat pea and the mummy field pea. None require extended notice at present.

Cystisus (no common name is given) vegetated slowly and made a slow growth. It appears to be hardy, remain-

ing green until November 5, when it was three feet high, with small and woody stalks. It has produced no fodder as yet.

Yellow millo maize is a sorghum, and, like all other varieties of this species, grows slowly at first. Planted with corn, it was eight to twelve inches high when corn was thirty. It has the reputation of enduring drought well; but our seasons are not long enough for it, and I consider it of no value as a fodder crop here.

One of the dent corns from South Dakota appears to be a very valuable sort. It is a white variety. The seed of but two ears was planted, and upon soil of very ordinary fertility. The stalk is short and small, the ears large and deep kernelled, the variety early. The yield was at the rate of 89.6 bushels of grain to the acre.

The *spring wheat* and *black barley* did poorly, rusting and giving very small returns.

Horse Bean. — We received one peck of seed from a dealer in Montreal. It was planted in drills eighteen inches apart, in deep, clayey, rich soil, on April 29. The growth was vigorous and healthy, but few pods formed. The height was from four and one-half to five feet. It was cut from day to day, beginning July 17, and fed to cows, being highly relished. The total weight was 2,035 pounds, or at the rate of a little over 12 tons per acre. This yield of so highly nitrogenous a fodder makes it of possible value.

Sacaline. — Seed was procured of Grégory & Son of Marblehead, and sown in a bed in the open air April 23. The germination was slow, but good. Early in July the little plants were taken up and reset about three inches apart each way. About the middle of August plants were set in the field three feet apart each way. Two widely different soils were selected, — one a heavy, rich, moist loam, the other a dry, sandy loam. The plants in both soils lived well, and those in the moist, rich land made considerable growth, though not enough to be worth harvesting. A few stems cut and offered to cattle were freely eaten. The plant is perennial, and should next season produce considerable fodder which may prove valuable for green feed or for the silo.

Flat Pea. — The past is our second season with this much-lauded fodder plant. The germination last year was slow and imperfect. This year the plants have been gathered upon a lesser area, some being taken up to fill vacancies on the part left. The soil is light and dry. We have in the two seasons been at a very considerable expense, and as yet have no fodder; but, as the plant is perennial, this may come later. It is hardy with us upon light soil.

Mummy field peas are larger than the common Canada field pea, and about one-fourth to one-half more seed should be sown. We used at the rate per acre of one bushel of each with two bushels of oats for fodder. The mummy variety was not thick enough. In one respect it appears superior to the Canada; viz., it lodges less. This difference may, however, have been in part due to the fact that the mummy variety was the thinner in the field. The yields of the two fodder mixtures, as determined by calculation based upon small equal areas, were: oats and Canada pea, 21,760 pounds, and oats and mummy pea, 19,040 pounds, per acre.

Trial of Hay Caps.

Three kinds of hay caps have been subjected to careful comparative tests. The kinds tried were the Symmes' paper-board cap, oiled cotton, and cotton impregnated with tannin. The first was not fastened in place, its weight and construction rendering this less necessary than for the other forms. It, however, sometimes blew off in high winds. The others were fastened on by means of pins attached to cords at the corners.

Three trials were made, two with clover rowen which had been dried one day, and one with barn-yard millet which had been dried three days. After the caps were put on the first trial continued seven days; the second, two days; the third, with millet, seven days. During each trial there were one or more showers. In every trial the use of the cap was very beneficial. The paper cap excluded the rain most perfectly, and the hay in each trial came out in best condition. There was not much difference in the condition of the hay under the other two kinds of caps. As the

Symmes' paper cap can be put on fully twice as rapidly as the forms requiring fastening, it appears to be most useful. Its weight is an objection, and of course we are not yet able to report upon durability.

Experiment in Warming a Stable for Cows.

This experiment was continued during the winter of 1894–95, beginning December 18 and continuing until March 8. It will be remembered that our stable has two similar wings, one piped for hot-water heating. We aimed to maintain a temperature of about 55° F. in the warm stable. The other, of course, varied with the weather; but, as both stables are thoroughly constructed, even the "cold" side was seldom excessively cold. Six cows were used in the experiment, three on each side. We divided the time into four periods of equal length. At the close of the first period the cows changed stables. Here they were kept for two periods, and were then changed again. In this way we equalized conditions for the two stables. Between periods, when a change in the position of the cows was made, we allowed an interval of one week, that the animals might become accustomed to and under the influence of their new quarters before the records were begun.

The apparent influence of the warm stable upon milk and butter fat production is small. On the average, there is rather more milk and butter fat in the warm stable. The most certain effect brought out by our experiments is the lowering of the percentage of fat in the milk in the warm stable. The increased product will not nearly pay the cost of heating the stable.

With moderate artificial heat better ventilation can be secured, without making the stable too cold for the comfort of its occupants, than is possible without artificial heat. This should have an ultimate influence upon health; but the tuberculin test, as well as physical examination, indicated all our animals to be in perfect health at the close of the experiments, hence we as yet have nothing conclusive upon this point.

Poultry Experiments.

These have been upon a small scale, on account of location and limited equipment. We have had four coops of laying fowls, raised in 1894. There have been from fifteen to nineteen hens in a house. The houses are exactly alike in construction, each with nesting and laying room, ten by twelve feet; and scratching shed, eight by ten feet in size. The hens were of two breeds, — light Brahma and barred Plymouth Rock.

We have confined our attention to two points: —

1. The relative value for egg production of vegetable as compared with animal substances for furnishing the greater part of the albuminoids and fats of the food.

2. The relative value for egg production of animal food in the form of dried "animal" or "flesh" meals, as compared with cut fresh bone.

1. Vegetable v. Animal Albuminoids.

Two experiments have been carried out: one extending from Dec. 9, 1894, to Feb. 12, 1895; the other from June 1 to Oct. 31, 1895. The first experiment began when the fowls were pullets, hatched in May; the second includes a considerable proportion of the time occupied in the annual moult. These facts account in part for the small egg production. During the summer experiment the fowls had the run of small grass yards.

The material used in the first experiment to furnish the vegetable substitute for animal food was soja-bean meal. This is an exceptionally rich vegetable substance, in composition excelling meat meal, as will be seen from the figures below: —

Composition of the Dry Matter, Soja-bean Meal and Meat Meal (Per Cent.).

FOOD.	Flesh Formers.	Fat.	Heat and Fat Formers.
Soja-bean meal,	34.37	16.38	45.22
Meat meal,	35.98	8.31	–

Moisture: soja-bean meal, 11.61 per cent.; meat meal, 13.68 per cent.

In the second experiment linseed and cotton-seed meal were used as the vegetable substitutes for animal foods.

In both experiments the fowls received a variety of foods, but the nutritive ratio was always kept substantially the same for the two coops under comparison. In the first experiment the ratio was one flesh former to four and one-half fat and heat formers; in the second it was one to four and seven-tenths. The foods used in the first experiment, in addition to the soja-bean meal and meat meal, were: cut alfalfa, wheat, oats and middlings in one coop; in the other, boiled potatoes, ground clover, wheat, wheat middlings and cut bone.

In the second experiment the supplementary feeds were: wheat, oats, bran and middlings for the vegetable coop; and wheat, oats, wheat meal, bran and linseed meal for the animal food coop.

Both coops had pure water, artificial grit and ground oyster shells always before them; and all other conditions were made as nearly as possible alike.

The result in both experiments has been favorable to the animal food, as shown by the following summary: —

Vegetable v. Animal Foods for Hens.

FOOD.	Duration of Experiment (Days).	Daily Cost per Fowl.	Number of Eggs.	Water-free Food per Egg (Pounds).	Cost per Egg.
Vegetable food, first coop, .	64	$0 0021	11	23.830	$0 3410
Vegetable food, second coop,	153	0027	400	.917	0150
Animal food, first coop, . .	64	0024	79	3.554	0550
Animal food, second coop, .	153	0033	622	.773	0115

In the above estimate of cost no charge is made for labor and no allowance for the droppings. The production of eggs is, of course, very small, even in the best period; but it should be remembered that, at the very time when hens always lay most freely, our fowls were taken out of this experiment for breeding purposes, viz., from February 12 to June 1.

The results are, however, decisive against the vegetable food and in favor of the animal in so far as effect upon egg

production is concerned. The fowls receiving animal food were, moreover, in much better condition at the close of these experiments than the others.

2. *Dried Animal or Meat Meal compared with Cut Fresh Bone.*

There were two experiments. The general conditions were the same as in the comparison of vegetable and animal foods. The nutritive ratio was nearly the same in coops compared. A variety of foods was supplied; artificial grit and oyster shells were given *ad lib.* The results are shown below: —

FOOD.	Duration of Experiment (Days).	Daily Cost per Fowl.	Number of Eggs.	Water-free Food per Egg (Pounds).	Cost per Egg.
Dried meat meal, first coop, .	64	$0 00266	185	1.185	$0 0170
Dried meat meal, second coop,	153	00280	417	1.051	0152
Cut fresh bone, first coop, .	64	00248	163	1.154	0170
Cut fresh bone, second coop, .	153	00300	444	.978	0143

These results are rather indecisive, as in one experiment the meat meal and in the other the cut fresh bone gave the better results, as measured by egg production. The condition of the fowls receiving the meat meal has, however, been uniformly better than in the other coops. There has been no diarrhœa. In the second experiment, two hens in the cut-bone coop died; and at the close of this experiment the fowls which had been receiving meat meal were nearer through moulting than the others.

Of course it is possible that the bone was not used in the best practicable manner; but it appears to be exceedingly difficult to secure an even distribution of this food. Some hens almost invariably secure more than their share, and this is equally true, whether the cut bone be scattered or mixed in a mash. The result is frequent diarrhœas. The meat meal, on the other hand, can be evenly mixed in a mash, so that all fowls share alike, as it cannot be picked out. Our results indicate that it is a safer feed than the bone; it is also a much cheaper feed; and, if it will give practically as many eggs, it is to be preferred. This experiment will be repeated.

REPORT OF ENTOMOLOGIST.

CHARLES H. FERNALD.

During the past year a great deal of time has been devoted to arranging and supervising experiments on the gypsy moth, and also to preparing, in conjunction with the field director, Mr. Forbush, a full report on this insect. The Commonwealth of Massachusetts has spent and is still spending large sums of money for its destruction, and in protecting the farmers of the State from the ravages of this notorious pest. It seemed wise and proper to devote much time and attention to the study of the gypsy moth and its habits, for the purpose of discovering the best and most economical methods for its destruction.

A large amount of time has been spent in preparing a complete account of our *Crambidæ*, which appears with six colored plates and structural details elsewhere in this report. This paper is designed to give all known scientific and practical knowledge that we possess about these insects, and it is hoped that the illustrations, in connection with the descriptions, will enable our farmers to determine any of these insects, and when they are found in large numbers in their grass lands, as often occurs, they may be better able to combat them.

Bulletin No. 28 was prepared by this division, and contains descriptions and illustrations of two species of canker worms, the army worm, the red-humped apple-tree caterpillar, the antiopa butterfly, the currant stem-girdler, the imported elm-bark louse and the greenhouse orthezia, together with methods of holding them in check.

On the 29th of March, my attention was called to some scale insects on several young plum trees on the grounds of

the horticultural department of the Massachusetts Agricultural College, which proved to be the dreaded San José scale. These trees, according to the record books, came from the J. T. Lovett Company, Little Silver, N. J., in the spring of 1894.

Wishing to determine whether any of these insects had survived the winter, I had two of the trees taken up and set out in the cold part of the insectary greenhouse, and the remaining infested trees were burned. Scales appeared on the growth of the previous year, so that the insects succeeded well at least during the summer of 1894. On June 10, live scales were observed on the trees transplanted to the insectary greenhouse, and on the 14th the young were swarming all over them, and even extended to some small apple trees growing near in the same part of the greenhouse. As this seemed to settle the question of their ability to survive our winters here in Amherst, or at least the winter of 1894–95, which was an average one, I had all these trees very carefully burned, to prevent any further spreading of the pest. As soon as it was discovered that the San José scale had been received here on nursery stock from outside of the State, I feared that other nurseries might have become infested in a similar manner, and therefore I sent Mr. Lounsbury, who was my assistant at that time, to different nurseries to look for them. He reported that on April 19 he found the San José scale on two plum trees, two pear trees and a rose bush in Roslindale, Mass. The plum trees were badly infested with living scales, while the pear trees and rose bush were but slightly so. The scales occurred on all parts of the trees, but were the least numerous on the new growth. The pear trees had been on the grounds for three years and the plum trees two years. Mr. Lounsbury was informed that these trees were obtained from a local agent at West Roxbury, who claimed to have purchased them from the Shady Hill nursery, Bedford, Mass. On April 23 Mr. Lounsbury visited the Shady Hill nursery, and found the San José scale alive in large numbers on several different varieties of apple trees. Mr. Kohler, in charge of the nursery, told him that these trees were brought from the Cambridge nurseries, where they had been growing three or four years.

The Cambridge nursery was then visited, and pear, peach and apple trees were found infested with the scale, and many of the worst-infested trees were dead. As no stock had been added to this nursery for three years, these trees must have been infested at least that length of time. I have not been able to learn from what source the stock in this Cambridge nursery was obtained.

On July 9 I received a twig of an apple tree from Mr. W. W. Rawson, with the request to inform him what the matter was with it. An examination showed that it was infested with the San José scale. Further correspondence revealed the fact that the twig came from an apple tree in the orchard of Mr. E. E. Cole, in the town of Scituate. Mr. Cole wrote me that the orchard contained ninety trees that were set out three years ago. It is situated in a protected spot, with trees on three sides, and is within two miles of the ocean in a direct line. He also wrote me that the trees were received from Mr. Rawson, who informed me that he obtained most of his nursery stock of that description from the Shady Hill Nursery Company.

It is therefore probable that the Shady Hill nurseries received infested stock from some outside nursery, possibly in New Jersey, and have unintentionally become a centre of infection for orchards in the eastern part of this State. To what extent this pest has become distributed through the State it is impossible to say, but that it is able to live and destroy fruit trees in some if not in all parts of the State seems evident. A complete account of this insect was prepared and published with illustrations in the Massachusetts Crop Report for August.

The correspondence is steadily increasing, and many letters about injurious insects are received from nearly every part of the State. Most of these letters call for information about such insects as are causing more or less damage, and it is very rarely that we are called upon to give information about insects that have merely excited the curiosity of the sender.

The elm-leaf beetle appears to be rapidly spreading in the State, and we have been called upon frequently during the year for information about this beetle. A bulletin will soon

be prepared on this and several other insects, which are so numerous as to cause much damage in various parts of the State, and about which we receive frequent inquiries.

Our studies on the cranberry insect are progressing as fast as other matters will permit, and it is our intention to prepare as complete a report on these insects as possible, at some future time.

REPORT OF HORTICULTURIST.

SAMUEL T. MAYNARD.

Owing to the recent separation of the horticultural and botanical divisions, the report from this division will partake more of an outline of the work to be undertaken than of results obtained.

The work has been carried on much in the same lines as in previous years. The season, up to the time of the severe hail storm, September 11, had been one that promised more than the average for the growth and perfection of nearly all of the crops under cultivation, and insects and fungous pests were not more than usually abundant. On September 11 one of the heaviest hail storms ever known in this section occurred, which resulted in almost the total destruction of the crops not matured at that time.

Protection of Crops from Insects and Fungous Diseases.

In growing the various fruit, vegetable and other crops, it is found necessary to protect them from insects and fungous pests, and much work has been done in using and testing insecticides and fungicides.

The lines of work pursued have been for the most part confined to testing large and small fruits, especially new varieties of promise; the various insecticides and fungicides recommended for their power to protect from common insect and fungous pests; all new varieties of vegetables and flowers sent in for trial by the originator or introducer, and some of the most promising obtained in the open market. Many new and promising ornamental trees and shrubs have been planted for comparison, and many new varieties of

flowering and bedding plants have been added to the collection under glass. Comparisons have also been made respecting the effects of various kinds and different combinations of fertilizers upon growing crops.

Equipment.

This division requires for comparison a large number of standard varieties. These are already provided in the college orchard, vineyards, garden and greenhouses. In this work of comparison the most careful, painstaking observation is demanded. Suitable land is also required for the best growth of each crop, and a great variety of implements and tools for cultivating the same. Each different process requires its own tool, and facilities for storage must be provided, in order to market to the best advantage.

Varieties of Fruits.

The varieties of fruits now under observation on the college grounds may be enumerated as follows: —

Apples, 150 varieties; pears, 67; peaches, 49; plums, 103 (including types of all the groups according to the latest grouping); apricots, 13; nectarines, 2; quinces, 8, and many seedlings; cherries, 33; grapes, 143, and more than 500 seedlings not fruited; currants, 20; gooseberries, 17; red raspberries, 25, and many seedlings of the Shaffer type; black-cap raspberries, 31; blackberries, 21; strawberries, 157 named varieties, and about 600 seedlings from carefully crossed and selected varieties. Besides the above, there are growing many of the newer fruits, like the Japanese wineberry, May berry, salmon berry, Logan berry, strawberry-raspberry, Rocky Mountain cherry, sand cnerry, June berry, Japanese walnut, Spanish, Japanese and hybrid chestnuts.

Spraying Outfit.

Machine Pumps. — The expense of applying insecticides and fungicides by hand pumps has been so great in the past that most of the work during the season just elapsed has been done with the Victor machine pump, resulting in a great saving of time, the power being applied by gearing attached to the

wheels. This pump was worked very satisfactorily with all growths except large trees, where the time required to spray a single tree is so great that the power acquired by the motion of the wheels becomes exhausted before the tree is thoroughly sprayed in every part. This has necessitated driving around the tree several times, or working the pump by hand. Even with this pump, however, tall trees cannot be readily reached, and to obtain more reliable and more constant power a *steam pump* is being constructed, which is guaranteed to carry three streams through the ordinary three-quarter-inch hose at one time, fifty feet high. This will enable the hose to be taken into tall ornamental trees, and the work to be done more effectually, economically and quickly than by any of the ordinary hand or machine pumps. The pump, engine and tank, holding one hundred to one hundred and fifty gallons, will be compactly mounted on a low truck, with wheels having six-inch tires and bolster springs, that it may be drawn over soft or rough ground with the least jolting possible. The weight of engine, pump, tank and truck is expected not to exceed eight hundred pounds, and when the tank is filled to be easily drawn by two horses.

Vegetables.

During the past season the following number of varieties of vegetables has been tested: —

Asparagus, 3 varieties; artichoke, 2; beans, 11; beets, 6; Brussells sprouts, 2; carrots, 6; cabbages, 8; cauliflowers, 5; celery, 10; cucumbers, 6; sweet corn, 7; dandelion, 2; endive, 2; kohl-rabi, 2; lettuce, 5; onions, 6; parsley, 2; peppers, 4; egg-plant, 6; peas, 7; pumpkins, 4; radishes, 6; squashes, 11; spinach, 3; parsnips, 6; tomatoes, 16; rhubarb, 4.

Seed Testing.

Seed testing is of the greatest practical importance to the farmer, market gardener and the florist, but at the same time it is most difficult so to conduct it as to obtain entirely satisfactory results. It will be hardly possible, with the present equipment, to make trial of the seeds of all of the varieties of farm and garden crops put upon the market by different

growers, and it is planned to procure only those that are most largely grown and the new promising kinds. In the outline for this work it is proposed to make at least three tests of each variety under each of several methods adopted in the greenhouse, and three in the field at different dates, yet under as nearly the same conditions as possible. It is also proposed to test the quality of the products of each under ordinary field culture. In this way it is hoped to arrive at some definite conclusions respecting the comparative value of each variety for general cultivation, and the dependence of the crop on the quality of the seed.

Plants in the Greenhouses.

In these houses most of the promising new varieties of plants grown by the commercial florist are tested as they are introduced. The following is a partial list of the number of varieties tested: —

Carnations, 18 varieties; chrysanthemums, 30; coleus, 14; begonias, 31; bulbs, 55 species and varieties; geraniums, 24; roses, 12; violets, 3, etc.

REPORT OF METEOROLOGIST.

LEONARD METCALF.

Aside from the mere routine work incident to keeping up the daily meteorological records and observations, the work of the department has been confined chiefly to the compilation of data accumulated at this observatory during the past seven years. The records of this station, from the time of its foundation in 1889 to date, have been compiled and summarized, and tables have been prepared showing the maximum, minimum and mean observations. These results will probably be published in the form of a special bulletin early next year.

But few new instruments have been added to our equipment, — one or two new clocks for the self-recording instruments replace the old ones in case of emergency or mishap, and thus preserve the continuity of the records; and a new signal service standard Fahrenheit thermometer, for comparing and verifying the accuracy of the temperature indications of the wet and dry bulb thermometers, and the maximum, minimum and self-recording thermometers.

The ozone observations have been discontinued, owing to their uncertainty and unreliability. The amount of rainfall will henceforth be recorded on top of the tower, as on the ground, by means of a United States signal service standard rain gauge (as well as by the self-recording gauge), in order that the tower readings may be perfectly comparable with those of the ground.

REPORT OF CHEMIST.

DEPARTMENT OF FOODS AND FEEDING.

Conducted by J. B. Lindsey, with the assistance of C. S. Crocker, B.S., chemist; E. B. Holland, B.S., chemist; G. A. Billings, B.S., assistant in feeding department.

Part I.

Laboratory Work.

(*a*) Fodder analyses.
(*b*) Water analyses.
(*c*) Dairy products.

Part II.

Feeding Experiments and Dairy Studies.

(*a*) Chicago gluten meal *v.* King gluten meal.
(*b*) Chicago gluten meal *v.* Atlas meal.
(*c*) Composition of cream from different cows.
(*d*) Wheat meal *v.* rye meal for pigs.
(*e*) Salt hays and meadow hay (values for feeding).

Part I.

(*a*) FODDER ANALYSES.

We have received and analyzed for farmers during the year 49 samples of various grains, by-products and coarse feeds. We publish here only those having any particular interest, or that have more recently appeared in our markets. For analyses of all such feeds see complete table at the end of this report.

All cattle feeds have been divided into five groups of substances: —

1. *Crude ash* means the mineral ingredients contained in the plant or seed, such as lime, potash, soda, magnesia, iron, phosphoric acid, sulphuric acid and silicic acid. The ash serves to build up the bony structure of the animal.

2. *Crude cellulose* is the coarse or woody part of the plant; straws and hays contain large quantities, while in the grains and most by-products but little is present. It serves to produce vital energy and fat.

3. *Crude fat* includes the fats, waxes, resins, etc. It serves the same purpose as cellulose, but furnishes two and one-half times as much vital energy.

4. *Protein* is a general name for all nitrogen-containing bodies found in plants. It might be called "vegetable meat." It is a source of energy, possibly a source of fat, and *is the only source of flesh.*

5. Nitrogen-free extract consists of starch, sugars and gums. These substances produce energy and fat. Cellulose and extract are termed carbohydrates.

The grains are valuable chiefly for their extract matter, protein and fat. They contain very little cellulose. The estimation of protein and fat is as a rule all that is necessary to enable one to judge whether or not they are of superior, average or inferior quality.

Many by-products contain as small amounts of crude cellulose as do the grains. Others, such as brans, dried brewers' grains, etc., have from 7 to 12 per cent.

An estimation of the protein and fat only is necessary to enable one to get at their comparative values. Such feeds are bought chiefly for their protein content.

One-fourth to one-third of coarse fodders — hays, straws, corn fodders — consists of crude cellulose. This cellular matter, in so far as it is digestible, is equal in value to the digestible extract matter. Coarse fodders naturally constitute the bulk of the feed for neat stock, and are valuable chiefly for their cellular and extract matter (carbohydrates).

Analyses.

(*a*) *Gluten Feeds.* — The gluten feeds are being sold very largely in Massachusetts markets at the present time. They consist of the skin or hull, the germ and the gluten of the corn kernel. The Pope gluten feeds do not contain the germ.

CONSTITUENTS.	Peoria.	Peoria.	Peoria.	Buffalo.	Pope (White).	Pope (Yellow).
Water (per cent.),	9.00	9.00	9.00	9.00	9.00	9.00
Crude ash (per cent.),	.91	–†	–†	.81	1.22	.99
" cellulose (per cent.),	7.69	–†	–†	7.10	6.04	6.35
" fat (per cent.),	11.72	13.07	11.04	11.92	7.39	7.21
" protein (per cent.),	17.45	21.51	22.00	23.40	25.12	24.60
Extract matter (per cent.),	53.23	–†	–†	47.77	51.23	51.85
	100.00	–	–	100.00	100.00	100.00

† Not determined.

These feeds are kiln dried, and contain from 7 to 10 per cent. of water. For the sake of comparison, they are all calculated to a uniform basis (9 per cent.). It will be noticed that the per cent. of protein varies from 17.5 to 25; *i. e.*, a 30 per cent. variation. The per cent. of fat also varies from 13.07 to 7.21; *i. e.*, a 45 per cent. difference. These feeds, with such wide variations in protein and fat content, are sold practically at the same price per ton.

(*b*) *Oat Feeds.* — This material is being very largely offered. It consists of oat hulls, poor oats and the refuse from oat-meal factories, mixed with more or less ground

barley, bran, inferior corn meal, etc. It is sold under a variety of names, such as oat feed, Quaker oat feed, corn and oat chop, etc.

CONSTITUENTS.	Oat Feed.	Corn and Oat Chop.	Quaker Oat Feed.	Oat Feed.	Oat Feed.
Water (per cent.),	10.00	10.00	10.00	10.00	10.00
Crude ash (per cent.),	4.47	3.60	4.87	-†	3.73
" cellulose (per cent.),	15.13	11.62	14.68	14.88	11.76
" fat (per cent.),	3.64	4.11	3.68	3.73	4.23
" protein (per cent.),	10.70	10.69	12.33	11.32	10.18
Extract matter (per cent.),	56.06	59.98	54.44	-†	60.10
	100.00	100.00	100.00	-	100.00

† Not determined.

We cannot commend this article to farmers. It is made up of different materials, and in putting it upon the market the manufacturer simply is enabled to work off inferior articles and refuse. It of course has considerable feeding value, but the several ingredients can be bought cheaper in other materials, such as corn meal, gluten feed, etc.

(*c*) *Gluten Meal.* — This feed stuff is prepared from the hard, flinty portion (gluten) of the corn.

Since July the attention of the station has been frequently called to the difference in the appearance of the Chicago gluten meal. It formerly had a golden yellow color. A portion of that now appearing on the market has a light or grayish appearance. The manufacturers claim that this is due to the use of white corn.

CONSTITUENTS.	CHICAGO.						Pope Gluten Meal.
	OLD PROCESS.	IMPROVED PROCESS.					
	Yellow.	White.	White.	White.	Yellow.	Yellow.	
Water (per cent.),	9.00	9.00	9.00	9.00	9.00	9.00	9.00
Crude ash (per cent.),	.90	1.19	-†	-†	-†	-†	.58
" cellulose (per cent.),	1.10	3.39	-†	-†	-†	-†	1.72
" fat (per cent.),	6.20	6.02	7.20	6.51	6.59	6.93	7.55
" protein (per cent.),	30.50	38.39	38.77	37.41	38.96	42.21	36.60
Extract matter (per cent.),	52.30	42.01	-†	-†	-†	-†	44.55
	100.00	100.00	-	-	-	-	100.00

† Not determined.

The analyses of the so-called improved Chicago meal show it to contain a higher per cent. of protein than the old-process meal contained. The manufacturers claim that this is due to a more complete removal of the starch. Both the white or light and yellow meal have practically the same composition, and are consequently equally valuable for feeding.

(*d*) *Brans and Rice Meal.*

CONSTITUENTS.	Rex Bran.	Cotton-seed Meal Bran.	Cotton-seed Hull Bran.	Rice Meal.
Water (per cent.),	11.00	11.00	11.00	10.00
Crude ash (per cent.),	3.35	2.87	1.93	8.40
" cellulose (per cent.),	18.74	28.60	34.99	5.63
" fat (per cent.),	2.71	3.89	1.09	13.17
" protein (per cent.),	8.90	10.50	2.34	11.59
Extract matter (per cent.),	55.30	43.14	48.65	51.21
	100.00	100.00	100.00	100.00

The above brans are all much inferior to the average wheat bran. The rice meal is a good average sample of its kind, and possesses a feeding value similar to corn meal. Experiments are now in progress with this meal.

(*b*) WATER ANALYSIS.

To determine the healthfulness of a water for drinking, the object is to note the quantity, kind and condition of the organic matter, as well as the total amount of mineral constituents it contains.

All water contains more or less mineral matter in solution, derived from the soil through which it percolates. Moderate quantities (see limit below) are beneficial, and impart to the water a pleasant taste.

The method employed at this laboratory for testing waters is what is known as Wancklyn's process. This chemist interprets the results of his mode as follows: —

1. More than 71 parts per million of chlorine, accompanied by more than .08 part per million of free ammonia and more than .10 part per million of albuminoid ammonia, indicate that the water is polluted with sewage, decaying animal matter, urine, etc. (The amount of chlorine in water depends somewhat on the section of the State from which it comes.)

2. Total solids should not exceed 571 parts per million.

3. Water showing less than 5 degrees as here expressed is termed soft; between 5 and 10 degrees, medium; and above 10 degrees, hard.

"Albuminoid" ammonia is the ammonia derived from the breaking up of vegetable or animal matter in water, as a result of the action of certain chemicals in the process of analysis. Its presence indicates, therefore, that the water contains these matters in solution.

The presence of free or actual ammonia in water shows that these animal or vegetable substances are being decomposed by various bacterial growths. Much free ammonia is an indication that a water is suspicious or even dangerous for drinking.

Chlorine is one of the two components of common salt, and salt is always found both in the urine of human beings

and in that of domestic animals, as well as in many waste waters. Excess of chlorine would therefore make it clear that a water contained sewage of some kind.

It is impossible, from a chemical analysis, to say whether or not a water is contaminated with the specific germ of any contagious disease. This is the work of the bacteriologist.

Character of Waters tested.

We have tested for farmers during the year 124 samples of water. Of these, 81, or 65.3 per cent., were found safe; 18, or 14.5 per cent., rather suspicious; and 25, or 20.2 per cent., dangerous for drinking. Five samples contained very noticeable quantities of lead derived from the lead pipe through which the waters flowed. Soft waters are especially liable to take up the lead. Every one is cautioned against the use of lead pipes, as waters containing this substance are very injurious to the health.

Sample Analyses of Different Waters.

Quality of Water.	Parts per Million.					Clark's Degrees.
	Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Total Solid Matter.	Mineral Solids.	Hardness.
Excellent,	–*	.04	5.00	70.0	46.0	–†
	.02	.07	3.00	70.0	32.0	1.43
	.01	.03	4.00	–†	–†	5.43
Good,	.01	.10	19.00	104.0	54.0	3.25
	.02	.12	7.00	–†	–†	1.11
	.04	.06	8.00	–†	–†	1.26
Suspicious,	.08	.07	18.00	–†	–†	–†
	.04	.11	38.00	336.0	186.0	10.15
	.04	.20	22.00	–†	–†	–†
Dangerous,	.16	.14	35.00	–†	–†	5.71
	.20	.08	22.00	–†	–†	–†
	.26	.48	2.00	84.0	22.0	2.47

* None. † Not determined.

It was not considered necessary to publish the analysis of each water analyzed during the year.

Instructions for sampling and sending Water.

In dipping water from springs or drawing it from open wells, be sure that no foreign material falls into it. Do not take a sample from water that has stood in a pump for any length of time. Send at least two quarts, in *an absolutely clean* vessel. Waters received in dirty vessels are not tested, as the results would be of no value. A clean new stone or earthen jug is to be preferred.

Answer briefly the following questions in regard to the water: —

1. Is it well, shallow spring or hydrant water?
2. Do you suspect it to be the cause of any contagious disease?
3. Do you suspect lead poisoning?
4. What is the character of the ground through which it percolates?
5. How far is the well from house or barn?

(c) DAIRY PRODUCTS.

Milk, Cream, etc.

We have received and tested for farmers during the year 87 samples of milk, 18 samples of cream and 4 samples of butter; 24 samples of butter have also been analyzed for the Dairy Bureau. It is not considered necessary to publish these analyses here. They will be found tabulated at the end of the report.

Information.

Average cow's milk has approximately the following percentage composition: —

	Per Cent.		Per Cent.
Water,	87.0	Albumen,	.50
Fat,	3.7	Milk sugar,	5.10
Casein (curd),	3.0	Ash,	.70

For practical purposes, we generally estimate the percentage of total solids (which includes everything except water) and fat.

For convenience, the Massachusetts milk standard for 1895, as well as the average composition of cream, skim and butter milks, follow: —

CONSTITUENTS.	Massachusetts Standard.	Skim-milk.		Cream.		Butter-milk.
		Deep Setting.	Separator.	Deep Setting.	Separator.	
Total solids (per cent.),	13.00*	9.50	-	26.5	-	8.33
Milk fat (per cent.),	3.70	.32	.10	18.0	25.-35.	.27
Solids not fat (per cent.),	9.30	-	-	-	-	-

* During May and June, 12 per cent.

Instructions for sending Milk.

Milk or cream should be sent by morning express, if possible. It should be marked "Immediate Delivery," and should not be sent later than Thursday of each week. Send one pint of milk and one-half pint of cream, preferably in Lightning or Mason fruit jars. *Be sure the vessels are perfectly clean.* Mix the milk or cream thoroughly before taking the sample, by pouring from one vessel to another.

PART II.

(*a*) CHICAGO GLUTEN MEAL *v.* KING GLUTEN MEAL.

EXPERIMENT WITH COWS.

Object of the Experiment.

The object of the experiment was to compare the relative merits of the two gluten meals for milk production.

Chicago Meal. — The general character and appearance of this meal is well known.

King Meal. — This meal is very probably a by-product from corn, the process of manufacture being somewhat different from that employed in case of the Chicago meal. It contains apparently no husks or germs; the fat from the germ, however, is present, making the meal very rich in this latter substance. For the sake of comparison the composition of the two meals is given below: —

CONSTITUENTS.	Chicago.	King.
Water (per cent.),	9.33	7.34
Crude ash (per cent.),	.13	1.38
" cellulose (per cent.),	1.57	1.30
" fat (per cent.),	4.17	18.48
" protein (per cent.),	33.64	35.57
Extract matter (per cent.),	51.17	35.93

Plan of the Experiment.

Four grade cows were employed, in different stages of lactation. The preliminary feeding period lasted seven days, and the feeding period proper seven days. All other feeds

excepting the two gluten meals remained constant during the experiment.. The data will be found in Table I. The following method was employed to overcome the natural milk shrinkage. The cows were divided into two lots. During the first period cows I. and III. received the King meal, at the same time cows IV. and VI. were receiving the Chicago meal; during the second period this order was reversed. This experiment was in operation during June, 1894. The cows were allowed the run of the barn-yard during the day, and so far as possible all conditions were identical during the entire time.

TABLE I.

PERIODS.	Number of Animals.	Length of Feeding Period (Days).	Average Live Weight (Pounds).	Average Daily Rations. Total. Wheat Bran (Pounds).	King Gluten Meal (Pounds).	Chicago Gluten Meal (Pounds).	Rowen (Pounds).	Digestible. Protein (Pounds).	Carbohydrates (Pounds).	Fat (Pounds).	Total (Pounds).	Nutritive Ratio.
King, .	4	10	935	4.5	4.5	-	18	3.30	9.65	1.15	14.1	1:3.8
Chicago, .	4	10	937	4.5	-	4.5	18	3.16	10.49	.56	14.2	1:3.7

TABLE II. — *Average Yield and Cost of Milk.*

PERIODS.	Total Cost of Feeds (Dollars).	Total Yield of Milk (Quarts).	Average Daily Yield per Cow (Quarts).	Cost of Milk per Quart (Cents).
King, ...	$6 61	318.4	11.36	2.08
Chicago, ...	6 61	314.4	11.23	2.10

Comments on the Results.

Table I. shows that the cows consumed the same amount of digestible matter daily in each period.

Table II. shows that the daily yield of milk and the cost per quart were practically identical in each period.

The Chicago meal was in its usual good condition. In spite of the fact that the King meal contained nearly 20 per

cent. of fat, no rancid odor or taste was noticed after the meal had been in the barn six months. Its mechanical condition was all that could be desired. The objection to feeding by-products especially rich in fat is that, if they are fed alone in large quantities (above 3 quarts daily) or fed in combination with other material of a similar nature, the tendency is to cloy the appetite of the animal, or — in warm weather especially — to produce inflammation of the milk glands.

In a daily grain ration of 9 pounds we would not advise feeding over 3 or 4 pounds of but one by-product having above 7 to 8 per cent. of fat.

The principal criticism on this experiment would naturally be the shortness of its feeding periods. This could not have been well avoided. The results obtained, however, are, it is believed, sufficient to give one an idea of the comparative value of the two grains.

(b) CHICAGO GLUTEN MEAL v. ATLAS MEAL.

Experiment with Cows.

Object of the Experiment.

The experiment was undertaken for the purpose of noting the feeding value of the new by-product Atlas meal, as compared with Chicago gluten meal.

Atlas Meal. — This is a comparatively new article in Massachusetts markets. It consists of the hull, gluten and germ of different grains left behind in the process of alcohol manufacture. It comes into the market ground fairly fine, and contains about the same amount of protein as does the Chicago meal. The amount of cellulose and fat is, however, in excess of the latter. The composition of the two grains follows: —

CONSTITUENTS.	Chicago.	Atlas.
Water (per cent.),	9.00	10.00
Crude ash (per cent.),	.13	.37
" cellulose (per cent.),	1.57	10.75
" fat (per cent.),	4.18	13.75
" protein (per cent.),	33.75	33.57
Extract matter (per cent.),	51.37	31.56

Plan of the Experiment.

The experiment was in operation during January and a part of February, 1895. The cows, four in number, were grades. The feeds consisted of hay, corn and soja-bean ensilage, bran, Chicago gluten meal and Atlas meal. The ensilage, hay and bran remained constant during the entire experiment. The preliminary feeding periods lasted seven days, the two periods proper ten days each. To overcome the natural milk shrinkage the following arrangement was instituted. The cows were divided into two lots. In Period I., cows 3 and 6 were fed Chicago meal at the same time

that cows 4 and 5 were receiving Atlas meal. In Period II. this order was reversed. The cows were kept in the barn during the entire experiment, and were treated precisely alike during both periods. Two composite samples (three days each) of milk were tested during each period. The tables following give the average results from the four cows: —

TABLE I.

PERIODS.	Number of Animals.	Length of Feeding Periods (Days).	Average Live Weight (Pounds).	AVERAGE DAILY RATIONS. TOTAL.					DIGESTIBLE.				
				Wheat Bran (Pounds).	Chicago Meal (Pounds).	Atlas Meal (Pounds).	Corn and Soja-bean Ensilage (Pounds).	Hay (Pounds).	Protein (Pounds).	Carbohydrates (Pounds).	Fat (Pounds).	Total (Pounds).	Nutritive Ratio.
Atlas,	4	10	943	4	-	4	42.1	5	2.46	9.15	1.17	12.78	1:4.9
Chicago,	4	10	944	4	4	-	40.6	5	2.62	9.38	.84	12.84	1:4.4

TABLE II. — *Average Yield and Cost of Milk and Butter Fat.*

PERIODS.	Total Cost of Feed (Dollars).	Total Yield of Milk (Quarts).	Average Daily Yield per Cow (Quarts).	Cost per Quart (Cents).	Total Amount of Butter Fat (Pounds).	Total Cost of Butter Fat per Pound (Cents).
Atlas,	$7 40	420.7	10.52	1.76	40.57	18.24
Chicago,	7 56	423.3	10.58	1.79	40.17	18.82

TABLE III. — *Average Composition of Milk.*

NUMBER OF COW.	PER CENT. SOLIDS.		PER CENT. FAT.	
	Atlas.	Chicago.	Atlas.	Chicago.
3,	14.13	14.33	4.22	4.72
4,	13.86	13.65	4.88	4.60
5,	13.38	13.16	4.17	4.12
6,	14.33	13.71	4.52	4.06
Average,	13.93	13.71	4.45	4.38

Results.

The cost and quantity of milk and butter fat are so nearly equal in each case as to be considered practically identical. If the quality of the Atlas meal is maintained, it can be regarded as an excellent food for milch cows and neat stock in general.

(c) WHAT CONSTITUTES A "SPACE" OF CREAM.

J. B. LINDSEY AND GEO. A. BILLINGS.

In the report of the State Experiment Station for 1894 it was shown that the butter fat in the cream gathered from 165 different farmers varied from 11 to 22 per cent. Such figures only serve to emphasize the unreliability of the "space" as a basis for payment.

During the past autumn we have tested the cream raised by the deep-setting process from each of the six cows belonging to the station. The conditions were precisely alike in each case, the milk being immersed for the same length of time, and the temperature of the water maintained at 38 to 40 degrees. The cows were all fresh in milk, having calved from one to two months previously.

History of the Cows.

Cow I., grade Ayrshire, six years old, weighing 800 pounds, yielding about 4 per cent. fat in milk.

Cow II., native, nine years old, weighing 900 pounds, yielding 4 per cent. fat in milk.

Cow III., grade Ayrshire-Jersey, seven years old, weighing 850 pounds, yielding 4.2 per cent. fat in milk.

Cow IV., grade Jersey, six years old, weighing 1,050 pounds, yielding 5 per cent. fat in milk.

Cow V., grade Durham, seven years old, weighing 1,050 pounds, yielding 3 per cent. fat in milk.

Cow VI., grade Durham-Jersey, about seven years old, weighing 1,000 pounds, yielding 5 per cent. fat in milk.

Table I. shows the daily results and the average for the three days (two days in case of cows V. and VI.).

TABLE I.

NUMBER OF COW.	Number of Days.	Milk per Day (Pounds).	Spaces Cream per Day.	Per Cent. of Fat in Cream.	Per Cent. of Fat in Skim-milk.
I., . . .	1, ...	25.90	8.10	16.90	.20
	1, ...	26.00	7.50	16.60	.15
	1, ...	25.50	7.80	16.10	.17
	Average, .	25.80	7.80	16.53	.17
II., . . .	1, ...	21.50	5.30	16.15	.55
	1, ...	22.00	5.50	15.90	.57
	1, ...	22.75	5.90	17.30	.55
	Average, .	22.08	5.57	16.45	.56
III., . . .	1, ...	25.50	11.50	11.20	.25
	1, ...	26.87	10.80	12.05	.30
	1, ...	26.50	11.60	12.70	.25
	Average, .	26.30	11.30	11.98	.27
IV., . . .	1, ...	25.95	8.10	21.00	.18
	1, ...	27.12	8.40	21.45	.20
	1, ...	25.00	8.10	22.65	.13
	Average, .	26.02	8.20	21.70	.17
V., . . .	1, ...	28.00	7.00	15.70	.17
	1, ...	30.63	7.10	16.20	.15
	Average, .	29.31	7.05	15.95	.16
VI., . . .	1, ...	31.12	10.90	20.25	.15
	1, ...	31.50	8.80	19.45	.13
	Average, .	31.31	9.85	19.85	.13

TABLE II. — *Showing the Results on the Basis of 25 Pounds of Milk per Cow.*

NUMBER OF COW.	Spaces of Cream.	Per Cent. of Fat in Cream.	NUMBER OF COW.	Spaces of Cream.	Per Cent. of Fat in Cream.
I., . . .	7.56	16.53	IV., . . .	7.89	21.70
II., . . .	6.30	16.45	V., . . .	6.01	15.95
III., . . .	10.74	11.98	VI., . . .	7.87	19.85

Cows I., II. and V. produced the smallest number of spaces of cream, containing 16 to $16\frac{1}{2}$ per cent. of fat. Cow III. produced nearly 11 spaces of cream with 12 per cent. of fat. Cows IV. and VI. produced nearly 8 spaces of cream each, containing from 20 to nearly 22 per cent. of fat.

According to the present system, cream is paid for at the same price per space, whether it contains 12, 16 or 22 per cent. of butter fat, *i. e.*, whether equal quantities of such cream will produce 12, 16 or 22 pounds of butter. Under this system a farmer with a herd of extra butter-producing cows, yielding cream by the deep-setting process, containing 19 to 22 per cent. of fat, receives no more money than another farmer who produces a like quantity of cream testing but 15 or 16 per cent. of fat. *The injustice must be apparent* to every thinking farmer. The investigation, as shown in the above tables, might have been carried still further by weighing the cream, calculating the *amount* of butter fat produced, and seeing how much butter a given number of spaces of each cow's cream would produce. This was done, however, in last year's investigation, and, at the risk of repetition, the summary of the results bearing on this point is presented in Table III. Our object in the present experiment has been simply to show how the per cent. of fat in the cream of six individual cows varied under exactly similar conditions.

TABLE III. — *Summary of Results obtained in 1894 with Cream gathered from 165 Farmers, showing Butter Equivalent from 100 Spaces of Graded Cream, and Value of Same.*

Pounds of Butter Fat from 100 Spaces of Cream.	Number of Patrons.	Per Cent. of Patrons.	Equivalent to Butter (Pounds).	Value of Butter at 25 Cents per Pound.
8-12, ...	10	6.1	13.42*	$3 35
12-13, ...	23	14.0	14.58	3 64
13-14, ...	52	31.5	15.75	3 94
14-15, ...	41	24.9	16.92	4 23
15-16, ...	30	18.2	18.08	4 52
16-18, ...	9	5.5	19.83	4 96

* Figured on the basis of 11.5 pounds of butter fat.

A full explanation of the Babcock system (by which the farmer is paid for the number of pounds of butter fat actually furnished by him), and how to put it into practical operation, has already been published.* This system offers encouragement for every one to improve his herd by weeding out the unprofitable cows and putting in their places only those that will produce good yields of rich milk.

Under the space system those farmers having extra cows that are well taken care of simply help out their shiftless neighbors who keep inferior animals. That the latter class of farmers is glad to be thus aided, and is as a rule opposed to any change, is not to be wondered at. How long the more thrifty, painstaking farmers will be willing to continue this, is a question for them to decide.

* "Creamery Practice," by J. B. Lindsey, published by Dairy Bureau, 20 Devonshire Street, Boston, Mass.

(*d*) WHEAT MEAL *v.* RYE MEAL FOR PIGS.

Object of the Experiment.

In this experiment it was intended to compare the feeding values of wheat and rye meal, when fed in combination with skim-milk to growing pigs.

Plan of the Experiment.

The pigs were divided into two lots, two barrows and a sow being in each lot. The experiment was divided into three periods, covering in all 106 days. It was intended, in the first period, to feed 3 ounces of meal to each quart of milk, but the supply of milk being limited, some Peoria gluten feed was added to keep the ratio of protein to carbohydrates as 1 to 3.5.

In the second period 4 quarts of milk were fed daily, together with sufficient wheat or rye meal to satisfy appetites.

In the third period 4 quarts of milk were fed daily, in connection with equal parts of wheat or rye meal and corn meal to satisfy the appetites of the animals. Sufficient water was added to the milk and meal to furnish the necessary amount of liquid. The pigs were fed three times daily.

Table I. — *Feeding Plan.*

PERIOD.	Number of Days.	Feed.	Nutritive Ratio.
I., . .	58	3 ounces wheat or rye meal to each quart of milk, . .	1:3.6
II., . .	13	4 quarts milk daily, and wheat or rye meal to satisfy appetites.	1:4.0
III., . .	35	4 quarts milk, and equal parts wheat or rye meal and corn meal to satisfy appetites.	1:5.3

Table II. — *Average Daily Gain (Pounds).*

LOT.	Period I.	Period II.	Period III.	Total Average Daily Gain.
I., wheat, ...	1.06	1.21	1.49	1.22
II., rye, ...	1.00	1.15	1.20	1.10

Table III. — *Total Feed consumed.*

Lot I. (Wheat).

PERIODS.	Skim-milk (Quarts).	Wheat Meal (Pounds).	Peoria Feed (Pounds).	Corn Meal (Pounds).	Nutritive Ratio.
I.,	744.0	205.1	73.5	-	1:3.6
II.,	195.0	114.0	-	-	1:4.0
III.,	450.0	212.5	-	212.5	1:5.2
Total,	1,389.0	531.6	73.5	212.5	-
Equal to dry matter,	283.7*	468.0	68.3	180.6	-

* Pounds.

Lot II. (Rye).

PERIODS.	Skim-milk (Quarts).	Rye Meal (Pounds).	Peoria Feed (Pounds).	Corn Meal (Pounds).	Nutritive Ratio.
I.,	744.0	205.10	73.5	-	1:3.8
II.,	195.0	114.00	-	-	1:4.4
III.,	450.0	183.75	-	183.75	1:5.4
Total,	1,389.0	502.80	73.5	183.75	-
Equal to dry matter,	283.7*	432.40	68.3	156.20	-

* Pounds.

Table IV.

	Lot I.	Lot II.
Average live weight at beginning of experiment (pounds),	33.33	34.20
Average live weight at end of experiment (pounds),	162.70	150.00
Average gain of each pig (pounds),	129.37	115.80
Average daily gain (pounds),	1.22	1.10
Dry matter required to produce 1 pound live weight (pounds),	2.58	2.71
Skim-milk actually returned per quart (fraction of cent),	.65	.55
Cost of feed for each pound of live weight gained (cents),*	4.25	4.58
Price received per pound of live weight (cents),	4.80	4.80

* On basis of following prices for feed: skim-milk, 2 cents per gallon; wheat and rye, $24 per ton; Peoria gluten feed, $21 per ton; and corn meal, $23 per ton.

Comments on Results.

Both lots of pigs made very fair gains, and the results as a whole compare favorably with other experiments, when skim-milk was fed with other grains. The average daily gain was nearly $1\frac{1}{4}$ pounds, and the dry matter required to make 1 pound of live weight averaged 2.65 pounds. The skim-milk returned .6 of one cent per quart, and the live weight cost 4.37 cents per pound, allowing skim-milk to be worth one-half cent per quart, and the grains as noted. The wheat meal seemed to give rather better results, especially in the last period. During this latter period the pigs fed on the rye-meal ration were off feed a good deal of the time, and gained less in weight. If the experiment had been continued longer, the results would have been still more in favor of the wheat meal.

Suggestions for Feeding Wheat or Rye Meal.

With pigs weighing from 30 to 100 pounds, feed 3 to 6 ounces meal to each quart of milk; with pigs weighing from 100 to 175 pounds, feed skim-milk at disposal (4 to 6 quarts per pig), and equal parts of wheat or rye meal and corn meal to satisfy appetites.

(e) SALT HAYS AND MEADOW OR SWALE HAY.

A. — Digestibility.
B. — How to feed them.

Summary of Results.

(a) Black grass, high-grown salt hay, branch grass and low meadow fox grass are all valuable fodder articles. In the present experiment black grass contained more protein and showed a higher average digestibility, and is therefore superior to the other three hays. There is no wide difference, however. Timothy hay shows more total digestible organic matter, but is noticeably inferior to three of the salt hays in digestible protein. Black grass might be classed as but little inferior to average timothy hay. High-grown salt hay, branch grass and fox grass resemble each other very closely in feeding value.

(b) Salt hays at average market prices are decidedly cheaper to feed than English hay.

(c) Meadow or swale hay is a very inferior article. It contained 150 to 200 pounds less digestible matter than did the salt hays, and but 39 per cent. of digestible dry matter.

(d) Hays containing much less than 50 per cent. of digestible dry matter should be regarded as of very inferior quality.

A. — Digestibility.

At the request of the experiment station, farmers in the vicinity of Newburyport sent four samples of salt hay. It was the intention of the writer to analyze these hays and test their comparative digestibilities. The hays were named as follows: —

1. Black grass (fine, and of dark color; consisted almost exclusively of *Juncus bulbosus*).
2. High-grown salt hay.
3. Branch grass.
4. Low meadow fox grass.

The low meadow fox grass appeared to consist practically of what is also called rush salt grass (*Spartina juncea*), and both the high-grown salt hay and the branch grass were composed of this as a basis, mixed with more or less coarse grass, probably *Spartina stricta*, variety *glabra*. The branch grass contained rather more of the coarse material than did the high-grown salt hay.

A sample of meadow or swale hay was also obtained, through the kindness of Mr. Chas. J. Peabody of Topsfield, in which vicinity large quantities are cut yearly. This hay grows in the fresh-water meadows, and is composed of fresh-water grasses, sedges, brakes and wild flowers.

The digestion tests were made with sheep, because these animals are much easier to work with, and give at the same time similar results as do cows and steers.

How the Digestible Matter of a Feed is determined.

First ascertain the amount and composition of the feed consumed by an animal in a given length of time, also the amount and composition of the fæces or undigested portion excreted in the same time on the basis of dry matter. The difference between them will represent the amount of the various constituents of the food digested.

The percentages of the constituents digested are called the digestion coefficients.

TABLE I. — *Composition of Hays.*

[The analysis of each hay is given on the basis of 15 per cent. of water, for the sake of comparison.]

FODDER CONSTITUENTS.	Black Grass.	High-grown Salt Hay.	Branch Grass.	Low Meadow Fox Grass.	Meadow Hay.	Timothy Hay for Comparison.
Water,	15.00	15.00	15.00	15.00	15.00	15.00
Crude ash,	9.91	6.92	8.75	4.96	5.27	4.30
" cellulose,	22.78	22.45	22.50	22.58	26.40	28.40
" fat,	2.23	2.13	1.88	2.18	1.59	2.40
" protein,	8.08	6.36	7.03	6.06	6.77	6.30
Nitrogen-free extract matter,	42.00	47.14	44.84	49.22	44.97	43.60
	100.00	100.00	100.00	100.00	100.00	100.00

TABLE II. — *Showing Average Digestion Coefficients obtained with Two Sheep.*

FODDER CONSTITUENTS.	Black Grass.	High-grown Salt Hay.	Branch Grass.	Fox Grass.	Meadow Hay.	Timothy Hay for Comparison.
Total dry substance,	59.5	53.0	56.0	53.0	39.0	58.0
Crude cellulose,	60.5	50.0	52.0	51.0	33.0	53.0
" fat,	41.5	47.0	32.0	24.0	44.0	61.0
" protein,	63.0	63.0	62.5	57.0	34.0	48.0
Nitrogen-free extract matter,	57.0	53.0	54.0	52.0	46.0	63.0

TABLE III. — *Showing Pounds of Digestible Organic Matter in 2,000 Pounds of the Several Hays, assuming Each Hay to contain an Average Amount of Water (15 Per Cent.).*

FODDER CONSTITUENTS.	Black Grass.	High-grown Salt Hay.	Branch Grass.	Fox Grass.	Meadow Hay.	Timothy Hay for Comparison.
Crude cellulose,	275.6	224.4	234.0	230.2	174.24	301.00
" fat,	18.5	20.0	12.0	10.4	14.03	29.28
" protein,	101.8	80.0	87.8	69.0	46.02	60.40
Extract matter,	479.8	499.6	484.2	511.8	413.72	549.36
Total,	875.7	824.0	818.0	821.4	648.06	940.04

The teachings of the above tables will be found summarized at the beginning of the article. The writer has hesitated about making too sharp distinctions between the several kinds of salt hay, in view of the fact that he has worked with but one sample of each kind. It is well known that late-cut hays are inferior in per cent. of protein and less digestible than early-cut hays; and the writer has no means of knowing with certainty, either from the appearance of the samples or otherwise, whether or not they were cut at the same stage of growth. Very few blossoms were to be found indicative of an early cutting. It is also recognized that the condition and situation of the land exert an influence upon the quality of the hay. On the other hand, the hays were selected by men practically familiar with such material, and pronounced fair samples of their kind.

B. — How to feed Salt and Meadow Hays.

(a) *Salt Hays.*

Only general directions can be given. First, these hays, having a value approaching an average English hay, can be fed in place of the latter article in so far as composition and digestibility (*i. e.*, quality) are concerned. In the second place, however, the amount of salt they contain will exert a controlling influence on the quantity that the animal can consume. The per cent. of salt in the four samples received was as follows: —

	Black Grass.	High-grown Salt Hay.	Branch Grass.	Fox Grass.	Average English Hay.
Per cent. salt,	6.35	3.20	4.09	2.51	1.50

This per cent. would probably vary from time to time, depending on the frequency with which the salt water came in contact with the meadows, etc. Should black and branch grasses contain on an average as much salt as found in the present case, it would hardly seem wise to feed over one-third to one-half of these grasses in the entire coarse fodder ration, while in case of the high-grown salt hay and the fox grass two-thirds to even the entire coarse fodder ration could consist of these hays. The experience of practical feeders can and has undoubtedly solved this problem. The majority of farmers will probably prefer to feed about one-half salt hay and one-half English hay or other coarse material.

Coarse fodders can for practical purposes be fed *ad libitum; i. e.*, the animals can be given all they will consume. This can be left to the judgment of the practical feeder.

Grain Rations (on basis of milch cows of 1,000 pounds live weight). — The following rations are combined to go with the coarse fodders: —

I.		II.	
	Pounds.		Pounds.
Cotton-seed meal,*	100	Linseed meal,*	100
Wheat bran, ...	100	Pope or King gluten meal,* .	100
Corn meal,†.	100	Wheat bran, ...	200
Mix and feed 6 to 9 quarts daily.		Feed 7 to 9 quarts daily.	

III.		IV.	
	Pounds.		Pounds.
Chicago gluten meal,* . .	100	Gluten meal, ...	100
Wheat bran, ...	100	Corn meal, ...	100
Gluten feed,‡	100	Feed 6 quarts daily.	
Feed 6 to 9 quarts daily.			

V.	
	Pounds.
Cotton-seed meal, ...	100
Wheat bran, ...	100
Feed 8 quarts daily.	

* Cotton-seed meal, linseed meals and the various gluten meals can be substituted one for the other. Cotton-seed meal, King and Pope gluten meal, on account of the high percentage of fat they contain, should not be fed together in the same ration.

† Chicago maize feed, Buffalo and Peoria or other gluten feeds can be used interchangeably.

‡ Gluten feeds can usually be substituted for corn meal with good effect.

(b) *Meadow Hays (for Milch Cows of 1,000 Pounds Live Weight).*

Meadow hay, being of inferior nutritive value, must be supplemented with feed stuffs containing large amounts of digestible matter, — especially protein, — in order to secure good results.

Coarse Fodder Ration 1. — Feed all the meadow hay the animal will eat.

Grain Rations for above.

I.		II.	
	Pounds.		Pounds.
Corn meal, ...	200	Corn meal, ...	100
Cotton-seed meal, ...	100	Wheat bran, ...	100
Feed 9 quarts daily.		Cotton-seed meal, ...	100
		Feed 10 quarts daily.	

III.

	Pounds.
Wheat bran,	100
Gluten feed,	100
Feed 14 to 16 quarts daily.	

Coarse Fodder Ration 2. — About one-half English hay and one-half meadow hay, or about one-half corn ensilage (30 pounds) and all the meadow hay the animal will eat.

Grain Rations for Above.

I.		II.	
	Pounds.		Pounds.
Corn meal,	150	Wheat bran,	100
Cotton-seed meal,	100	Gluten feed,	100
Feed 7 quarts daily.		Feed 10 to 12 quarts daily.	

Remarks. — The writer questions the wisdom of a system of farming in which much labor is devoted to securing meadow hay for feeding to farm animals. The large amount of grain necessary to be fed in order to secure reasonably nutritive rations calls for a considerable outlay of money, which renders the various rations of doubtful economy.

The tendency of modern dairy farming is to raise crops containing more nitrogenous matter (protein), and thus reduce the amount of grain to be purchased.

To farmers who have been gathering and feeding large quantities of meadow hay the writer would make the following suggestions: —

In addition to English hay, raise annual crops, such as peas and oats, vetch and oats and Hungarian grass. Cut these for hay. Grow corn fodder and soja-bean fodder, and put into a silo in the proportion of two parts corn to one part soja beans. Such a system will give large amounts of nutritious winter feed, and will enable one to get along with one-half of the grain feed mentioned above.

How to purchase Grains.

In making up grain rations cost must be considered, and one should be familiar with the fluctuating market values of the several feed stuffs in order to make economical combinations. The following figures show the approximate commercial values of the different feeds, based on the amount of digestible protein they contain: —

Wheat bran,	$18 00	$14 00
Corn meal,	19 00	15 00
Wheat middlings,	21 00	16 00
Brewers' grains,	21 00	16 00
Malt sprouts,	23 00	18 00
Gluten and maize feeds,	28 00	22 00
Atlas meal,	31 00	24 00
Old-process linseed meal,	31 00	24 00
New-process linseed meal,	32 50	25 00
Gluten meals,	35 00	27 00
Cotton-seed meal,	35 00	27 00

The above figures do not express the relative physiological effect of the different grains, but show their comparative values in digestible protein after figuring the digestible carbohydrates and fat at a definite price. They can be used as guides in purchasing.

Compilation of Analyses of Fodder Articles and Dairy Products,

MADE AT

AMHERST, MASS.

1868-1896.

Prepared by C. S. Crocker.

A. Fodder Articles.

B. Fertilizing Ingredients in Fodders.

C. Dairy Products.

A. Composition and Digestibility of Cattle Feeds.

[Figures equal percentages or pounds in 100.]

NAME.	Analyses.	COMPOSITION.										DIGESTIBILITY.							
		FRESH OR AIR-DRY SUBSTANCE.						WATER-FREE SUBSTANCE.				FRESH OR AIR-DRY SUBSTANCE.				WATER-FREE SUBSTANCE.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
I. Green Fodders.																			
Fodder corn,	33	74.90	1.21	5.2	.5	2.0	11.7	25.2	2.4	9.8	56.7	2.7	.40	1.1	8.7	25.2	1.8	5.2	42.0
Fodder-corn ensilage,	38	78.30	1.20	6.0	.8	1.9	11.8	27.7	3.8	8.7	54.4	4.1	.60	.9	7.9	18.8	3.0	4.5	36.4
Corn and soja-bean ensilage,	3	76.50	2.60	7.3	.9	2.5	10.2	31.2	4.0	10.5	43.5	-	-	-	-	-	-	-	-
Oat and pea ensilage,	1	38.02	5.70	19.4	2.4	8.5	26.0	31.3	3.9	13.7	41.8	-	-	-	-	-	-	-	-
Millet and soja-bean ensilage,	6	75.70	3.00	7.3	1.0	3.0	10.0	30.2	4.0	12.3	41.4	-	-	-	-	-	-	-	-
Millet ensilage,	3	73.80	2.40	7.5	.8	1.7	13.8	33.3	3.1	6.6	52.3	-	-	-	-	-	-	-	-
Sorghum,	6	82.60	1.20	4.6	.3	1.5	9.8	26.7	1.5	8.7	56.3	2.7	.20	.7	7.2	15.8	1.1	4.0	41.7
Common millet,	9	64.60	1.70	11.0	1.0	2.6	19.1	31.0	2.7	7.5	54.0	-	-	-	-	-	-	-	-
Japanese millet (white head),	3	75.20	1.20	8.5	.6	2.2	12.3	34.5	2.3	8.7	49.6	-	-	-	-	-	-	-	-
Japanese millet (red head),	6	72.70	1.70	8.8	.5	1.9	14.4	32.1	2.0	6.9	52.9	-	-	-	-	-	-	-	-
Panicum miliaceum,	1	69.40	1.70	8.2	1.2	1.8	17.7	26.8	3.8	6.0	57.8	-	-	-	-	-	-	-	-
Panicum crus-galli,	2	72.90	2.10	7.6	.7	2.7	14.0	27.9	2.5	9.7	52.2	-	-	-	-	-	-	-	-
Mochi millet,	3	62.60	2.60	9.5	.7	3.7	20.9	25.6	1.8	9.9	55.7	-	-	-	-	-	-	-	-

Green oats,	6	74.00	2.10	7.8	.8	3.6	11.7	30.0	2.9	13.9	44.9	4.4	.50	2.5	8.5	17.0	1.7	9.7	32.8
Green barley,	1	79.10	1.80	7.9	.6	2.7	7.9	37.8	2.9	13.1	37.5	4.4	.40	1.8	5.8	21.1	1.7	9.2	27.4
Green rye,	2	72.00	1.60	8.9	.6	2.1	14.8	31.8	2.2	7.5	52.8	5.0	.40	1.5	10.8	19.1	1.3	4.2	38.5
Timothy (*Phleum pratense*),	2	65.40	1.70	11.3	.7	3.2	17.7	32.9	2.0	8.5	51.3	6.3	.40	1.5	11.7	18.4	1.1	4.1	33.9
Hungarian grass,	2	74.20	2.10	7.0	.5	2.6	13.6	27.9	1.7	9.4	53.0	4.8	.30	1.6	.9	19.0	.9	5.8	35.0
Vetch and oats (1 part vetch, 4 parts oats),	1	79.20	1.90	6.3	.8	2.8	9.0	30.3	3.9	13.3	43.7	4.2	.20	1.7	4.9	20.0	.7	8.0	23.6
Vetch and oats (1 part vetch, 9 parts oats),	3	81.00	1.70	6.4	.5	1.9	8.5	33.6	2.5	10.1	44.8	-	-	-	-	-	-	-	-
Vetch and oats (equal parts of each),	1	82.00	1.70	5.4	.5	3.0	7.4	29.8	2.8	16.8	41.3	-	-	-	-	-	-	-	-
Barley and peas,	1	83.90	1.30	5.4	.5	2.2	6.7	33.5	3.0	13.4	41.8	3.2	.24	1.7	4.1	20.1	1.3	10.3	25.5
Oats and peas,	2	84.00	1.30	4.7	.5	2.4	7.1	29.4	2.8	15.1	44.4	2.8	.24	1.8	4.3	17.6	1.2	11.6	27.1
Horse bean,	1	84.80	.90	4.3	.4	2.5	7.1	28.2	2.3	16.7	47.0	-	-	-	-	-	-	-	-
Flat pea,	2	78.80	1.90	5.2	.9	6.1	7.1	24.3	4.1	29.0	33.5	-	-	-	-	-	-	-	-
Soja bean,	14	75.50	2.50	6.5	1.1	4.2	10.2	26.5	4.6	17.3	41.6	3.4	.30	2.9	6.7	14.0	1.4	11.9	27.5
Soja bean (early white),	4	69.80	3.90	6.7	.8	5.0	13.8	22.8	2.7	16.5	45.2	-	-	-	-	-	-	-	-
Soja bean (early green),	1	69.90	3.90	7.1	1.2	5.8	12.1	23.5	3.9	19.4	40.2	-	-	-	-	-	-	-	-
Soja bean (early black),	1	82.20	2.30	4.5	.6	2.9	7.5	25.1	3.4	16.2	42.4	-	-	-	-	-	-	-	-
Soja bean (medium black),	1	76.90	2.90	5.0	1.6	5.0	8.6	21.7	6.8	21.7	37.1	-	-	-	-	-	-	-	-
Soja bean (late),	4	74.00	3.50	5.5	.7	5.9	10.4	21.1	2.8	22.8	39.7	-	-	-	-	-	-	-	-
Bokhara clover,	3	78.80	2.10	6.3	.6	4.2	8.0	29.5	3.0	19.7	37.9	-	-	-	-	-	-	-	-
Kidney vetch,	1	80.80	2.60	2.9	.7	3.5	9.5	14.9	3.5	18.4	49.9	-	-	-	-	-	-	-	-
Serradella,	3	82.40	1.90	5.3	.4	2.6	7.4	30.1	2.4	15.0	41.5	2.7	.30	2.0	19.0	15.1	1.6	11.3	26.1
Prickly comfrey,	1	86.80	2.80	1.5	.3	2.3	6.3	11.0	2.1	17.5	48.3	-	-	-	-	-	-	-	-

A. *Composition and Digestibility of Cattle Feeds* — Continued.

NAME.	Analyses.	Composition.										Digestibility.							
		Fresh or Air-dry Substance.						Water-free Substance.				Fresh or Air-dry Substance.				Water-free Substance.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
I. Green Fodders — Concluded.																			
Spurry,	1	72.30	2.60	7.0	.1	2.9	14.1	25.4	3.9	10.3	51.1	-	-	-	-	-	-	-	-
White lupine,	1	85.30	.70	4.6	.4	2.7	6.3	31.2	2.4	18.7	42.7	-	-	-	-	-	-	-	-
Yellow lupine,	1	86.00	1.50	3.8	.3	2.5	5.9	27.1	1.9	17.8	42.1	-	-	-	-	-	-	-	-
Spanish moss,	1	60.80	1.10	12.7	1.0	1.8	22.6	32.6	2.5	4.5	57.7	-	-	-	-	-	-	-	-
II. Hay and Dry Coarse Fodders.																			
English hay (mixed grasses),	60	14.00	5.40	26.7	2.4	8.1	43.1	31.1	2.8	9.5	50.3	16.0	1.1	4.8	25.4	18.7	1.4	5.6	29.7
Canada hay,	4	14.00	4.60	28.1	2.1	6.1	44.9	32.7	2.5	7.1	52.2	14.6	1.2	2.9	32.9	19.0	1.7	3.9	32.9
Rowen of mixed hays,	15	17.00	5.90	22.2	3.0	10.5	41.2	26.8	3.6	12.7	49.7	14.2	1.1	7.1	27.2	17.2	1.2	7.9	32.8
Timothy hay,	6	14.00	4.20	28.3	1.9	8.5	44.1	32.9	2.2	8.7	51.3	14.7	1.1	4.1	27.8	19.1	1.3	4.9	32.3
Red-top hay (*Agrostis vulgaris* With.),	4	14.00	4.30	28.3	1.4	6.8	45.2	32.9	1.6	7.9	52.6	17.3	.7	4.1	28.0	20.1	.8	4.8	32.6
Kentucky blue-grass (*Poa pratensis* L.),	2	14.00	7.20	29.7	1.8	7.5	39.7	34.6	2.1	8.7	46.2	-	-	-	-	-	-	-	-
Orchard grass (*Dactylis glomerata* L.),	4	14.00	6.10	30.0	2.5	8.1	39.3	34.9	2.9	9.4	45.7	18.3	1.4	4.9	21.6	21.3	1.6	5.6	25.1
Meadow fescue (*Festuca pratensis* Huds.),	5	14.00	7.90	31.7	1.6	5.8	39.8	36.9	1.9	6.8	46.3	-	-	-	-	-	-	-	-

Perennial rye-grass (*Lolium perenne* L.),	4	14.00	7.90	25.4	2.1	10.1	41.4	29.6	2.4	11.7	48.2	-	-	-	-	-	-	-	-
Italian rye-grass (*Lolium Italicum* A. Br.),	4	14.00	6.50	28.6	1.6	7.1	42.2	33.3	1.9	8.2	49.1	-	-	-	-	-	-	-	-
Hungarian grass,	1	14.00	4.90	27.5	1.9	8.2	43.5	32.0	2.2	9.5	50.6	18.7	1.2	4.9	29.1	21.8	1.4	5.7	33.9
Barn-yard grass,	1	14.00	8.60	29.0	1.7	13.1	32.9	33.7	2.0	15.3	38.2	18.2	1.0	8.1	21.7	21.2	1.2	9.5	25.2
Hay of black grass (salt),	2	16.00	7.70	24.4	2.4	6.8	41.6	29.1	2.9	8.1	49.5	14.6	1.0	4.3	23.3	17.5	1.2	5.1	27.7
High-grown salt hay,	1	16.00	7.00	22.2	2.1	6.3	46.6	26.4	2.5	7.5	55.5	11.0	1.0	4.0	24.7	13.2	1.2	4.7	29.4
Branch grass (salt),	1	16.00	8.80	22.3	1.8	7.0	44.4	26.5	2.2	8.3	52.8	11.5	.6	4.3	24.0	13.8	.7	5.1	28.5
Low meadow fox grass (salt),	1	16.00	5.40	22.3	2.2	6.0	48.6	26.6	2.6	7.1	57.9	11.4	.5	3.4	25.3	13.7	.6	4.0	30.1
Salt hay (variety unknown),	2	16.00	4.30	24.0	2.5	3.4	50.5	27.8	3.0	4.1	60.1	-	-	-	-	-	-	-	-
Vetch and oats (1 part vetch, 4 parts oats),	1	14.00	7.60	26.1	3.3	11.4	37.6	30.3	3.9	13.3	43.7	17.2	.6	6.8	20.3	20.0	.7	8.0	23.6
Vetch and barley,	2	14.00	5.30	27.9	2.0	11.9	38.9	32.4	2.3	13.9	45.2	18.4	.4	7.1	21.0	21.4	.5	8.3	24.4
Low meadow or swamp hay,	2	14.00	5.80	26.7	1.9	7.1	44.8	31.1	2.2	8.3	52.1	8.8	.8	2.4	20.6	10.2	1.0	2.8	23.9
Millet,	6	16.00	4.30	28.0	1.8	6.5	43.4	33.3	2.1	7.8	51.7	-	-	-	-	-	-	-	-
Oats in bloom,	1	15.00	5.60	30.6	2.4	5.5	42.0	34.1	2.9	6.6	50.0	17.1	1.5	3.9	30.7	19.0	1.8	4.6	36.5
Oats in milk,	1	15.00	5.20	29.2	2.3	9.3	39.1	34.3	2.7	10.9	46.0	16.3	1.4	6.5	28.5	19.2	1.7	7.6	32.6
Oats, ripe,	1	15.00	5.30	30.9	2.2	5.2	41.6	36.3	2.6	6.1	48.9	-	-	-	-	-	-	-	-
Winter rye in bloom,	1	15.00	5.40	28.1	2.2	9.1	40.2	33.0	2.6	10.7	47.3	15.7	1.4	6.4	29.4	18.4	1.6	7.5	34.5
Barley in milk,	1	15.00	4.20	24.7	2.4	8.8	44.9	29.1	2.8	10.3	52.8	13.8	1.5	6.2	32.8	16.3	1.7	7.2	38.5
Dry corn fodder,	4	20.00	4.10	23.4	1.4	6.2	45.9	29.3	1.8	7.7	56.1	15.2	1.0	3.7	34.0	16.1	1.4	4.1	42.6
Corn stover,	30	20.00	4.70	28.3	1.1	5.9	40.4	34.9	1.4	7.4	50.5	18.9	.6	3.1	25.9	23.4	.7	3.8	32.3
Common buckwheat,	1	8.50	13.40	17.8	2.7	16.4	41.2	19.4	3.0	17.9	45.1	-	-	-	-	-	-	-	-
Silver-hull buckwheat,	1	8.90	9.30	24.7	2.4	11.1	43.6	27.1	2.6	12.2	47.9	-	-	-	-	-	-	-	-

A. Composition and Digestibility of Cattle Feeds — Continued.

NAME.	Analyses.	COMPOSITION.										DIGESTIBILITY.							
		FRESH OR AIR-DRY SUBSTANCE.						WATER-FREE SUBSTANCE.				FRESH OR AIR-DRY SUBSTANCE.				WATER-FREE SUBSTANCE.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
II. Hay and Dry Coarse Fodders — Con.																			
Japanese buckwheat,	1	5.70	11.70	33.9	2.1	10.2	36.4	36.0	2.2	10.8	38.6	-	-	-	-	-	-	-	-
Teosinte,	1	6.10	6.60	27.1	1.2	9.1	49.9	28.9	1.3	9.7	53.1	-	-	-	-	-	-	-	-
Mammoth red clover,	3	11.40	8.70	24.4	1.9	14.0	39.6	27.5	2.1	15.8	44.8	-	-	-	-	-	-	-	-
Alsike clover,	6	10.00	10.70	23.6	2.3	14.9	38.5	26.2	2.6	16.6	42.7	12.5	1.2	9.2	27.2	13.9	1.3	9.8	30.3
Medium red clover,	2	5.60	8.50	28.7	2.4	14.0	40.8	30.4	2.5	14.8	43.3	15.2	1.2	9.2	30.0	16.1	1.3	9.8	30.7
Ground clover (poultry feed),	1	14.80	7.40	28.3	2.0	12.6	34.9	33.2	2.3	14.8	41.0	-	-	-	-	-	-	-	-
Lucerne (alfalfa),	6	9.70	7.20	27.7	1.7	12.3	41.4	30.7	1.9	13.6	45.8	13.6	1.0	9.5	22.3	15.0	1.2	10.5	26.4
Sand lucerne,	1	8.80	8.80	19.4	2.4	14.9	45.7	21.3	2.6	16.3	50.2	-	-	-	-	-	-	-	-
Bokhara clover,	5	8.00	8.30	27.5	2.9	15.8	37.5	29.9	3.2	17.2	40.7	-	-	-	-	-	-	-	-
Blue melilot,	1	8.20	13.70	25.0	1.6	12.7	39.8	27.2	1.7	13.8	42.4	-	-	-	-	-	-	-	-
Sainfoin,	3	9.90	7.80	21.6	3.1	15.7	41.9	24.0	3.4	17.4	46.5	-	-	-	-	-	-	-	-
Sulla,	2	9.40	8.40	18.8	2.5	15.4	45.5	20.7	2.8	17.0	50.2	-	-	-	-	-	-	-	-
Hairy lotus,	2	11.50	7.30	17.5	2.6	13.1	48.0	19.8	2.9	14.8	54.2	-	-	-	-	-	-	-	-
Summer rape,	1	11.10	16.30	16.2	3.4	12.8	40.2	18.2	3.8	14.4	45.3	-	-	-	-	-	-	-	-

Winter rape,	1	10.10	20.00	11.1	2.8	13.7	42.3	12.3	3.1	15.2	47.0	-	-	-	-	-	-	-	-
Dwarf Essex rape,	1	7.70	14.90	17.5	3.5	11.9	44.5	19.0	3.8	12.9	48.2	-	-	-	-	-	-	-	-
Soja bean,	4	12.10	7.30	21.1	4.1	14.2	41.2	24.0	4.7	16.2	46.8	11.2	1.2	9.8	27.2	12.7	1.4	11.2	30.9
Cow pea,	3	9.60	8.40	19.6	3.7	15.5	43.2	21.7	4.1	17.1	47.8	8.4	1.9	10.1	28.6	9.3	2.1	11.1	30.3
Small pea,	1	5.80	5.90	31.0	1.4	15.6	40.3	32.9	1.5	16.6	42.7	-	-	-	-	-	-	-	-
Flat pea,	1	8.90	8.60	29.0	1.7	21.9	29.9	31.8	1.9	24.0	32.9	-	-	-	-	-	-	-	-
Serradella,	3	9.60	6.40	22.8	2.4	15.4	43.4	25.2	2.6	17.0	48.1	11.4	1.8	10.0	27.3	12.6	2.0	11.1	30.3
Hairy vetch,	1	7.40	7.80	29.5	1.1	18.2	36.0	31.9	1.2	19.6	38.9	-	-	-	-	-	-	-	-
Common vetch,	2	8.90	7.50	27.7	2.3	13.8	39.8	30.4	2.5	15.1	43.8	15.0	1.4	10.5	26.3	16.4	1.5	11.5	28.9
Scotch tares,	1	5.80	11.60	26.1	1.6	18.4	26.5	30.9	1.9	22.0	31.4	-	-	-	-	-	-	-	-
Vetch and oats (equal parts each),	2	9.40	8.20	27.7	2.6	15.4	36.7	30.6	2.9	17.0	40.4	-	-	-	-	-	-	-	-
Vetch and oats (proportion unknown),	3	11.70	6.80	28.9	2.7	8.5	41.4	32.7	3.1	9.6	46.9	19.1	.5	5.1	22.4	21.6	.6	5.8	25.3
Vetch, oats and horse bean,	1	10.20	9.30	27.0	2.4	17.0	34.1	30.1	2.7	18.9	37.9	-	-	-	-	-	-	-	-
Horse-bean straw,	1	9.10	8.70	37.6	1.4	8.9	34.3	41.4	1.5	9.7	37.8	14.7	.7	4.4	22.0	16.1	.8	4.8	24.2
Soja-bean straw,	3	11.40	6.40	37.6	1.9	4.9	37.8	42.4	2.2	5.5	42.7	14.3	1.1	2.5	24.9	16.1	1.3	2.8	28.2
White daisy (*Chrysanthemum*, etc.),	1	9.60	6.40	32.6	2.1	7.0	42.3	36.1	2.3	7.7	46.8	15.0	1.3	4.1	28.3	16.6	1.4	4.5	31.3
Dry carrot tops,	1	9.80	12.50	12.3	1.8	19.1	45.5	13.6	2.0	20.1	50.4	-	-	-	-	-	-	-	-
Wheat straw,	1	6.20	4.50	33.7	1.5	6.8	47.3	35.9	1.6	7.2	50.5	18.9	.5	1.2	20.3	20.1	.6	1.2	20.3
Barley straw,	2	10.00	5.10	34.1	2.6	6.9	42.3	36.8	2.9	7.7	47.0	19.1	1.1	1.4	22.8	20.6	1.2	1.5	25.4
Japanese millet (white head),	1	8.50	4.70	32.0	2.2	7.0	45.6	35.0	2.4	7.7	49.8	-	-	-	-	-	-	-	-
Japanese millet (red head),	1	8.90	3.10	36.0	1.5	5.3	45.2	39.5	1.7	5.8	49.6	-	-	-	-	-	-	-	-
Japanese millet hay,	1	18.30	6.90	25.7	1.8	3.7	43.6	31.4	2.2	4.5	53.5	-	-	-	-	-	-	-	-

A. *Composition and Digestibility of Cattle Feeds* — Continued.

NAME.	Analyses.	Composition.										Digestibility.							
		Fresh or Air-dry Substance.						Water-free Substance.				Fresh or Air-dry Substance.				Water-free Substance.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
II. Hay and Dry Coarse Fodders — Con.																			
Millet straw,	1	13.40	5.90	36.2	1.2	4.3	39.0	41.8	1.4	5.0	45.0	-	-	-	-	-	-	-	-
Straw (*Panicum crus-galli*),	1	12.60	4.70	31.4	2.1	5.3	43.9	35.9	2.4	6.1	50.2	-	-	-	-	-	-	-	-
Straw (*P. miliaceum*),	1	12.20	5.40	37.1	2.6	3.4	39.3	42.2	3.0	3.9	44.7	-	-	-	-	-	-	-	-
Straw (*P. Italicum*),	1	19.70	5.00	33.3	1.3	3.4	37.3	41.5	1.6	4.2	46.4	-	-	-	-	-	-	-	-
III. Roots, Bulbs, Tubers, etc.																			
Beets, red,	7	87.80	1.10	.7	.1	1.5	8.8	6.0	.9	12.3	72.2	.3	-	1.1	8.0	2.6	-	9.2	65.7
Beets, sugar,	12	85.40	.90	1.0	.1	1.6	11.0	6.6	.7	11.2	75.5	1.0	.05	1.1	10.0	6.6	.35	10.2	75.5
Beets, yellow fodder,	4	88.50	1.00	1.0	.2	1.3	8.0	8.1	1.4	11.7	69.3	.4	-	1.0	7.2	3.3	-	8.8	62.1
Mangolds,	5	87.90	1.20	.8	.1	1.4	8.6	8.5	1.0	9.5	71.0	-	-	1.1	7.8	-	-	7.1	64.6
Ruta-bagas,	3	89.10	1.10	1.3	.2	1.2	7.1	11.8	1.5	11.0	65.9	1.0	.10	1.0	6.7	8.7	1.20	8.8	62.6
Turnips,	5	89.60	.90	1.2	.2	1.1	7.0	11.7	1.8	10.6	67.4	1.2	.20	1.0	6.8	11.7	1.80	9.5	65.4
Carrots,	5	89.00	.90	1.1	.2	1.0	7.8	9.1	2.1	8.8	71.6	-	-	-	-	-	-	-	-

Parsnips,	1	80.40	1.50	1.5	.7	1.3	14.6	7.7	3.4	6.9	74.6	-	-	-	-	-	-	-	-
Potatoes,	14	81.00	1.00	.5	.1	1.9	15.5*	2.6	.5	10.0	81.5†	-	-	.8	14.1	-	-	4.4	74.2
Artichokes,	1	77.50	1.10	.9	.2	2.9	17.4	4.2	1.0	12.8	77.2	-	-	-	-	-	-	-	-
Japanese radish (*merinia*),	1	93.30	.70	.7	.1	.5	4.7	10.3	1.1	7.5	70.8	-	-	-	-	-	-	-	-
Japanese radish (*niyas-hige*),	1	92.60	.70	.7	.1	.5	5.4	9.9	1.0	6.5	72.7	-	-	-	-	-	-	-	-
IV. Grains, Seeds, Fruits, etc.																			
Corn kernels,	29	10.60	1.50	1.9	4.8	10.9	70.3	2.1	5.4	12.2	78.6	-	-	-	-	-	-	-	-
Sweet corn kernels,	1	12.00	1.40	2.1	8.4	11.1	65.0	2.4	9.6	12.6	73.8	-	-	-	-	-	-	-	-
Wheat kernels,	2	10.60	1.80	2.2	1.6	12.0	71.8	2.5	1.8	13.3	80.4	-	-	-	-	-	-	-	-
Oat kernels,	2	11.10	3.10	8.4	5.8	13.2	58.4	9.5	6.5	14.8	65.7	1.7‡	4.1	10.4	43.2	1.9	4.6	11.7	62.6
Broom-corn seed,	1	14.10	2.20	7.1	3.5	9.6	63.5	8.3	4.1	11.2	74.0	-	-	-	-	-	-	-	-
Soja beans,	4	13.00	5.10	5.0	17.2	31.2	28.5	5.7	19.8	35.9	32.8	3.6	14.8	28.4	21.7	4.0	17.0	32.7	24.9
Red adzinki beans,	2	15.90	3.50	3.9	.7	20.6	55.4	4.6	.8	24.5	65.9	2.8	.5	18.1	47.6	3.3	.6	21.6	56.7
Saddle beans,	1	12.40	5.40	4.2	14.5	13.2	50.3	4.8	16.6	15.1	57.3	-	-	-	-	-	-	-	-
Horse beans,	1	10.30	3.90	7.3	.9	26.9	40.7	8.1	1.1	30.0	56.5	5.2	7.7	23.7	37.8	5.8	.9	25.4	52.5
Millet seed,	3	13.30	2.60	7.7	3.7	11.4	61.3	8.9	4.3	13.2	70.6	-	-	-	-	-	-	-	-
Chestnuts,	1	44.90	1.50	1.4	8.0	7.3	36.9	2.5	14.5	13.3	67.0	-	-	-	-	-	-	-	-
Cranberries,	1	89.40	.20	1.2	.6	.5	8.1	11.6	5.6	4.4	76.4	-	-	-	-	-	-	-	-
Apples,	2	77.70	.70	1.5	.5	1.0	18.6	6.6	2.3	4.3	84.7	-	-	-	-	-	-	-	-

* Starch (14 determinations) = 12.9 per cent. † Starch (14 determinations) = 68.2 per cent. ‡ With horses.

A. *Composition and Digestibility of Cattle Feeds* — Continued.

NAME.	Analyses.	Composition.										Digestibility.							
		Fresh or Air-Dry Substance.						Water-Free Substance.				Fresh or Air Dry Substance.				Water-Free Substance.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
V. Flour and Meal.																			
Corn meal,	38	13.60	1.40	1.8	3.3	9.5	70.4	2.1	3.8	11.0	81.5	-	3.0	5.7	65.5	-	3.5	6.6	75.6
Corn and cob meal,	37	10.50	1.40	6.7	3.7	9.0	68.7	7.5	4.2	10.0	76.7	3.1	4.2	5.4	59.6	3.4	4.5	6.0	67.5
Cooked feed (oats and corn),	1	5.50	3.80	8.2	5.0	14.0	63.5	8.7	5.3	14.8	67.2	-	-	-	-	-	-	-	-
Hominy meal,	4	10.00	1.10	29.6	.5	3.2	55.6	32.9	.6	3.6	61.7	-	-	-	-	-	-	-	-
Wheat meal,	1	11.50	2.00	2.9	2.0	12.1	69.5	3.3	2.2	13.7	78.6	-	-	-	-	-	-	-	-
Ground oats,	2	9.30	3.50	8.5	3.6	11.4	63.7	9.3	4.0	12.6	70.2	4.2	3.2	8.0	58.5	4.6	3.6	8.8	64.5
Ground barley,	5	13.10	2.40	5.7	1.9	11.3	65.6	6.5	2.2	13.0	75.5	2.8	1.7	7.9	60.4	3.2	2.0	9.1	69.5
Broom-corn meal,	1	13.50	2.10	6.9	3.5	9.7	64.3	8.0	4.1	11.2	74.3	-	-	-	-	-	-	-	-
Pea meal,	1	8.80	2.60	17.7	1.6	19.2	50.1	19.4	1.7	21.0	55.0	11.7	1.2	17.1	46.6	12.8	1.2	18.6	51.1
Peanut meal,	1	8.00	4.00	3.5	10.8	49.0	25.7	3.8	11.7	53.3	26.9	.8	9.5	44.6	23.6	.9	10.4	48.5	24.7
"Red Dog" flour,	1	9.70	1.90	1.4	4.4	22.6	60.0	1.5	4.9	25.0	66.5	-	-	-	-	-	-	-	-
Bean meal,	1	12.00	1.40	2.1	8.5	11.0	65.0	2.4	9.6	12.6	73.8	1.5	7.3	9.7	60.4	1.7	8.3	10.9	68.6

VI. By-products and Refuse.																			
Linseed meal, old process,	8	9.70	6.20	7.8	6.6	33.1	36.6	8.6	7.3	36.7	40.5	4.4	5.9	29.5	28.6	4.9	6.5	32.7	31.6
Linseed meal, new process,	8	8.30	5.90	8.5	2.9	36.1	37.3	9.3	3.2	39.4	41.7	6.3	2.7	30.7	32.1	6.8	3.0	33.5	35.9
Cotton-seed meal,	32	8.00	6.90	6.84	10.74	41.62	25.9	7.44	11.68	45.24	28.11	2.2	10.0	36.6	16.54	2.38	10.86	39.8	18.0
Cotton-seed bran,	2	9.80	3.10	28.5	3.4	10.6	44.6	31.6	3.8	11.8	49.4	-	-	-	-	-	-	-	-
Wheat bran,	49	10.60	6.80	9.8	4.5	16.1	52.2	10.9	5.0	18.0	58.5	2.2	3.2	14.0	40.4	2.4	3.6	14.0	40.4
Spring wheat bran,	4	10.40	5.70	10.5	5.0	16.0	52.4	11.7	5.6	17.9	58.4	2.5	3.8	12.8	36.6	2.8	4.2	14.3	40.9
Winter wheat bran,	3	11.00	6.00	8.5	2.8	15.1	56.5	9.6	3.2	17.0	63.3	2.3	1.8	11.6	36.7	2.6	2.0	13.1	41.1
Wheat middlings,	9	10.30	5.10	6.8	4.8	15.7	57.3	7.6	5.3	17.5	63.9	2.4	4.1	13.1	50.4	2.7	4.5	14.9	56.2
Rye bran,	2	10.90	3.80	3.6	2.3	15.9	63.5	4.0	2.6	17.8	71.3	-	-	-	-	-	-	-	-
Rye middlings,	1	12.50	3.50	3.3	5.9	11.6	64.2	3.7	5.6	13.2	73.5	-	-	-	-	-	-	-	-
Oat middlings,	1	6.40	4.50	18.3	3.5	11.3	56.0	19.5	3.7	12.1	59.9	-	-	-	-	-	-	-	-
Pea bran,	1	7.10	3.10	42.9	1.1	9.6	36.2	46.2	1.2	10.3	39.0	-	-	-	-	-	-	-	-
Buckwheat middlings,	1	11.50	4.80	4.6	6.6	22.6	49.9	5.2	7.5	25.5	56.4	-	-	-	-	-	-	-	-
Gluten meal,	38	9.00	.90	3.3	8.3	27.3	51.2	3.6	9.1	30.0	56.3	1.0	7.3	23.7	46.6	1.2	8.0	26.1	51.2
Gluten meal (Chicago), old process,	3	9.20	.80	1.1	6.2	30.4	52.2	1.2	6.8	33.5	52.5	-	5.8	27.1	48.4	-	6.5	29.8	53.5
Gluten meal (Chicago), new process,	4	9.60	1.30	2.4	6.0	38.4	42.3	2.6	6.6	42.5	46.8	-	-	-	-	-	-	-	-
Gluten meal (King),	2	7.20	1.70	1.4	19.1	34.6	35.9	1.5	20.6	37.4	38.7	-	18.1	31.8	30.2	-	19.6	34.4	32.5
Gluten feed (Buffalo),	15	8.10	.90	6.8	11.9	23.0	49.3	7.4	12.9	25.0	53.7	5.4	9.6	19.6	39.9	5.9	10.4	21.3	43.5
Gluten feed (Pope),	1	14.00	.70	1.5	14.0	33.2	36.6	1.8	16.3	38.7	42.4	-	-	-	-	-		-	-
Gluten feed (Peoria),	4	7.20	1.20	7.6	12.4	20.5	51.1	8.2	13.4	22.1	55.0	6.0	9.8	17.0	46.0	6.4	10.6	18.3	49.5
Maize feed (Chicago),	5	8.20	.60	7.5	7.1	24.9	51.7	8.2	7.7	27.1	56.3	6.2	6.5	21.2	45.5	6.7	7.1	23.2	49.5

A. *Composition and Digestibility of Cattle Feeds* — Concluded.

NAME.	Analyses.	Composition. Fresh or air-dry substance. Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Composition. Water-free substance. Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Digestibility. Fresh or air-dry substance. Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Digestibility. Water-free substance. Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
VI. By-products and Refuse — Concluded.																			
Starch feed (Pope),	1	5.50	.80	14.5	10.7	10.7	57.8	15.2	11.3	11.3	61.3	–	–	–	–	–	–	–	–
Atlas gluten meal,	2	9.90	1.10	11.1	12.8	34.3	30.8	12.3	14.2	38.1	34.2	–	12.9	25.0	25.9	–	11.6	27.8	28.7
Glucose feed (Richardson),	1	6.30	1.00	11.0	11.0	21.6	49.1	11.7	11.7	23.1	52.4	–	–	–	–	–	–	–	–
Corn germ meal,	1	9.30	7.60	8.3	10.7	25.7	38.4	9.2	11.8	28.3	42.4	–	–	–	–	–	–	–	–
Corn germ feed,	1	7.50	.80	13.0	11.3	10.0	57.4	14.1	12.2	10.8	62.0	–	–	–	–	–	–	–	–
Corn screenings,	1	11.10	2.10	2.9	4.0	7.4	72.5	3.3	4.5	8.3	81.5	–	–	–	–	–	–	–	–
Proteina (mixed feed),	4	8.40	2.50	10.0	6.6	21.7	50.8	10.9	7.2	23.7	55.5	–	–	–	–	–	–	–	–
Excelsior feed,	1	7.10	4.10	13.7	5.0	9.1	61.0	14.7	5.4	9.8	65.7	–	–	–	–	–	–	–	–
Oat feed,	10	7.50	4.90	13.0	4.3	11.8	58.5	14.1	4.7	12.5	63.4	–	–	–	–	–	–	–	–
Rye feed,	2	8.90	2.70	3.3	2.6	13.8	68.7	3.6	2.9	15.1	75.4	–	–	–	–	–	–	–	–
Cocoa-nut meal,	1	9.30	5.20	17.1	11.7	20.5	36.2	18.8	12.9	22.6	40.0	–	–	–	–	–	–	–	–
Rice meal,	1	9.90	8.40	5.7	13.2	11.6	51.2	6.3	14.6	12.9	56.1	1.5	11.2	7.3	44.0	1.6	12.4	8.1	48.9
Louisiana rice bran,	1	10.20	9.50	13.4	8.7	8.8	49.4	14.9	9.7	9.8	55.0	–	–	–	–	–	–	–	–
Peanut feed,	2	10.00	2.60	56.4	5.5	8.9	16.6	62.7	6.1	9.9	18.4	6.8	5.0	6.3	8.1	7.5	5.4	7.0	9.0

Peanut husks,	1	13.00	1.20	66.0	1.7	5.0	13.1	75.9	1.9	5.7	15.1	-	-	-	-	-	-	-	-
Bakery refuse,	1	13.30	10.10	.3	5.5	8.0	62.8	.4	6.4	9.2	72.4	-	-	-	-	-	-	-	-
Vinegar mash,	1	94.50	.20	.5	.5	.9	3.4	8.6	8.5	16.5	63.4	-	-	-	-	-	-	-	-
Refuse from starch works,	1	57.00	.40	3.2	4.4	9.6	25.4	7.5	10.2	22.4	59.0	-	-	-	-	-	-	-	-
Oat meal and barley refuse,	1	7.80	3.50	20.6	3.5	6.9	57.7	22.3	3.8	7.5	62.6	-	-	-	-	-	-	-	-
Glucose refuse,	1	6.70	1.10	4.5	9.9	19.7	58.0	4.8	10.6	21.1	62.3	-	-	-	-	-	-	-	-
Dried brewers' grain,	4	9.90	4.10	10.2	4.4	21.0	50.4	11.3	4.9	23.3	56.0	5.4	4.0	16.6	39.7	6.0	4.5	18.4	33.0
Malt sprouts,	1	15.40	5.30	12.5	3.3	23.0	40.5	14.8	3.9	27.2	47.8	4.3	3.3	18.4	27.9	5.0	3.9	21.6	33.0
Damaged wheat,	1	13.10	2.00	2.7	2.2	14.2	65.8	3.1	2.5	16.3	75.8	-	-	-	-	-	-	-	-
Cocoa dust,	1	7.10	6.30	5.5	24.1	14.4	42.6	5.9	25.9	15.5	45.9	-	-	-	-	-	-	-	-
Broom-corn waste,	1	8.70	4.50	35.9	.9	6.1	43.9	39.3	1.0	6.8	48.0	-	-	-	-	-	-	-	-
Refuse from cows' manger (ensilage),	6	72.90	2.60	9.4	.4	2.2	12.5	34.6	1.5	8.4	45.9	-	-	-	-	-	-	-	-
Cotton hulls,	3	10.00	2.70	41.5	2.5	4.4	39.0	46.1	2.8	4.8	43.3	19.5	2.2	.3	13.3	21.7	2.2	.4	17.7
Cotton-hull bran,	1	9.60	1.90	35.5	1.1	2.4	49.5	39.3	1.2	2.6	54.7	-	-	-	-	-	-	-	-
Apple pomace,	3	82.80	.40	2.9	.8	1.2	11.9	17.1	4.5	6.8	69.5	-	-	-	-	-	-	-	-
Apple-pomace silage,	1	85.30	.60	3.3	1.1	1.2	8.5	22.2	7.4	8.2	58.0	-	-	-	-	-	-	-	-
Sugar-beet pulp, from diffusion battery,	1	89.70	.10	2.5	.1	1.4	6.2	23.7	1.0	12.4	61.9	-	-	-	-	-	-	-	-
Sugar-beet refuse,	1	28.90	5.30	5.8	.3	8.6	51.1	8.1	.4	12.1	71.9	-	-	-	-	-	-	-	-
Corn cobs,	6	7.60	1.30	31.4	.5	2.7	56.5	34.0	.6	2.9	61.1	20.4	.3	.4	33.9	22.1	.3	.4	36.7
Palmetto root,	1	11.50	3.90	18.9	.4	3.4	61.9	21.3	.5	3.8	70.0	-	-	-	-	-	-	-	-

B. *Fertilizing Ingredients in Fodder Articles.*

[Figures equal percentages or pounds in 100.]

NAME.	Analyses.	Water.	Nitrogen.	Potassium Oxide.	Phosphoric Acid.	Valuation per 2,000 Pounds.*
I. Green Fodders.						
Fodder corn,	14	78.6	.41	.33	.15	$1 43
Fodder-corn ensilage,	7	80.2	.42	.39	.13	1 52
Corn and soja-bean ensilage,	1	71.0	.79	.44	.42	2 56
Millet and soja-bean ensilage,	5	75.8	.48	.5	.12	1 81
Millet ensilage,	3	73.8	.26	.62	.14	1 48
Sorghum,	7	82.2	.23	.23	.09	87
Mochi millet,	3	62.6	.61	.41	.19	2 06
Millet (*Panicum crus-galli*),	1	75.1	.46	.49	.11	1 70
Green oats,	3	83.4	.49	.38	.13	1 58
Green rye,	2	72.0	.30	.64	.12	1 48
Vetch and oats,	1	86.1	.24	.79	.09	1 93
Horse bean,	1	74.7	.68	.35	.08	2 06
Soja bean,	1	73.2	.29	.53	.15	1 37
Soja bean (early white),	1	66.6	.94	.91	.21	3 37
Soja bean (early green),	1	69.8	.84	.71	.20	2 92
Soja bean (medium black),	1	76.9	.80	.57	.18	2 74
Soja bean (late),	1	79.7	.60	.68	.14	2 26
Kidney vetch,	1	80.9	.56	.35	.09	1 78
Cow-pea vines,	1	78.8	.27	.31	.10	1 06
Prickly comfrey,	1	86.8	.37	.76	.12	1 77
Serradella,	2	82.6	.41	.42	.14	1 54
Common buckwheat,	1	84.7	.44	.54	.09	1 69
Flat pea (*Lathyrus sylvestris*),	1	78.6	1.05	.45	.14	3 14
Hungarian grass,	1	74.3	.39	.54	.16	1 54
White lupine,	1	85.4	.44	.25	.05	1 36
Yellow lupine,	1	85.1	.40	.44	.09	1 49
Spanish moss,	1	60.8	.28	.26	.03	96
II. Hay and Dry Coarse Fodders.						
English hay,	12	11.9	1.32	1.55	.30	5 02
Rowen,	13	18.5	1.63	1.50	.44	5 85
Timothy hay,	3	11.3	1.24	1.46	.34	4 78
Red top (*Agrostis vulgaris* With.),	4	7.7	1.15	1.02	.36	4 14

* The valuation is based on the following prices per pound of essential fertilizing ingredients: nitrogen, 12 cents; potassium oxide, 5 cents; phosphoric acid, 5 cents.

B. Fertilizing Ingredients in Fodder Articles — Continued.

NAME.	Analyses.	Water.	Nitrogen.	Potassium Oxide.	Phosphoric Acid.	Valuation per 2,000 Pounds.*
II. Hay and Dry Coarse Fodders — Con.						
Kentucky blue-grass (*Poa pratensis* L.),	2	5.3	1.32	1.69	.43	$5 29
Orchard grass,	4	8.8	1.31	1.89	.41	5 44
Meadow fescue,	6	8.9	.99	2.10	.40	4 87
Perennial rye-grass,	2	9.1	1.23	1.55	.56	5 06
Italian rye-grass,	4	8.7	1.19	1.27	.56	4 69
Salt hay,	1	5.4	1.18	.72	.25	3 80
Japanese millet (white head),	3	10.5	1.11	1.22	.40	4 28
Common buckwheat,	1	8.5	2.62	3.21	.53	10 02
Silver-hull buckwheat,	1	8.9	1.78	2.38	.86	7 51
Japanese buckwheat,	1	5.7	1.63	3.32	.85	8 08
Fodder corn,	7	7.9	1.76	.89	.54	5 65
Corn stover,	17	9.3	1.04	1.38	.29	4 17
Teosinte,	1	6.1	1.46	3.70	.55	7 75
Summer rape,	1	11.1	2.05	4.67	.57	10 16
Millet hay,	1	9.8	1.28	1.69	.49	5 25
Mammoth red clover,	3	11.4	2.23	1.22	.55	7 12
Medium red clover,	2	7.9	2.18	2.29	.45	7 97
Alsike clover,	6	9.9	2.34	2.23	.67	8 52
Lucerne (alfalfa),	4	6.3	2.08	1.46	.53	6 98
Bokhara clover,	2	7.4	1.98	1.83	.56	7 14
Blue melilot,	1	8.2	1.92	2.80	.54	7 95
Sainfoin,	1	12.2	2.63	2.02	.76	9 09
Sulla,	2	9.4	2.46	2.09	.45	8 36
Lotus villosus,	2	11.5	2.10	1.81	.59	7 44
Soja bean,	2	6.3	2.32	1.08	.67	7 32
Cow pea,	1	9.0	1.64	.91	.53	5 38
Small pea,	1	5.8	2.50	1.99	.59	8 58
Flat pea (*Lathyrus sylvestris*),	1	8.9	3.51	2.34	.82	11 58
Serradella,	2	7.4	2.70	.65	.78	7 91
Scotch tares,	1	15.8	2.96	3.00	.82	10 92
Spring vetch,	1	8.2	2.20	2.76	.74	8 78
Vetch and oats,	3	9.9	1.30	1.35	.56	5 03
Soja-bean straw,	1	13.0	.71	1.06	.26	3 02
Millet straw,	1	13.5	.69	1.76	.18	3 58

* See note on page 260.

B. *Fertilizing Ingredients in Fodder Articles* — Continued.

NAME.	Analyses.	Water.	Nitrogen.	Potassium Oxide.	Phosphoric Acid.	Valuation per 2,000 Pounds.*
II. Hay and Dry Coarse Fodders — Con.						
White daisy,	1	9.7	.28	1.25	.44	$2 36
Dry carrot tops,	1	9.8	3.13	4.88	.61	13 00
Barley straw,	2	10.0	1.13	2.41	.22	5 34
III. Roots, Bulbs, Tubers, etc.						
Beets, red,	8	87.8	.23	.44	.09	1 08
Beets, sugar,	4	87.0	.22	.48	.10	1 12
Beets, yellow fodder,	1	90.6	.19	.46	.09	1 01
Mangolds,	3	87.6	.15	.34	.14	84
Ruta-bagas,	3	89.1	.19	.49	.12	1 07
Turnips,	4	89.7	.17	.38	.12	81
Carrots,	3	89.0	.16	.46	.09	93
Parsnips,	1	80.3	.22	.62	.19	1 34
Potatoes,	4	80.1	.29	.51	.08	1 29
Artichokes,	1	77.5	.46	.48	.17	1 74
Japanese radish (*merinia*),	1	93.3	.08	.28	.05	52
Japanese radish (*niyas hige*),	1	92.6	.08	.34	.05	58
IV. Grains, Seeds, Fruits, etc.						
Corn kernels,	13	10.9	1.82	.40	.70	5 46
Corn and cob meal,	29	9.0	1.41	.47	.57	4 42
Oat kernels,	1	9.0	2.10	–	–	–
Soja beans,	2	18.3	5.30	1.99	1.87	16 58
Red adzinki beans,	1	14.8	3.24	1.54	.94	10 26
White adzinki beans,	1	16.9	3.33	1.48	.97	10 44
Saddle beans,	1	12.3	2.12	2.13	1.52	8 74
Japanese millet,	1	13.7	1.73	.38	.69	5 22
Common millet,	1	12.7	2.04	.36	.85	6 11
Chestnuts,	1	44.9	1.18	.63	.39	3 85
Cranberries,	1	89.4	.08	.10	.03	32
Apples,	2	79.9	.13	.19	.01	66
V. Flour and Meal.						
Corn meal,	3	14.1	1.92	.34	.71	5 66
Hominy feed,	1	8.9	1.63	.49	.98	5 38
Ground barley,	1	13.4	1.55	.34	.66	4 72
Wheat flour,	2	12.1	2.02	.36	.35	5 56

* See note on page 260.

B. Fertilizing Ingredients in Fodder Articles — Concluded.

NAME.	Analyses.	Water.	Nitrogen.	Potassium Oxide.	Phosphoric Acid.	Valuation per 2,000 Pounds.*
V. Flour and Meal — Con.						
Pea meal,	1	8.9	3.08	.99	.82	$9 20
Soja-bean meal,	1	10.8	5.89	2.23	1.57	17 94
Peanut meal,	1	8.0	7.84	1.54	1.27	21 63
VI. By-products and Refuse.						
Linseed meal (old process),	4	8.0	5.39	1.21	1.78	15 93
Linseed meal (new process),	5	7.9	5.83	1.25	1.69	16 93
Cotton-seed meal,	24	8.2	6.70	1.83	2.47	20 38
Wheat bran,	10	9.9	2.36	1.40	2.10	9 16
Wheat middlings,	2	10.2	2.75	.75	1.25	8 60
Rye middlings,	1	12.5	1.84	.81	1.26	6 47
Rye feed,	1	9.6	1.95	.98	1.56	7 22
Gluten meal,	5	8.5	5.09	.05	.42	12 69
Gluten feed (Buffalo),	5	8.2	3.72	.06	.34	9 31
Gluten meal (Chicago),	2	9.6	5.75	.06	.43	14 29
Gluten meal (King),	1	7.8	5.69	.08	.69	14 43
Dry distillery feed (Atlas),	1	11.2	5.30	.16	.23	13 50
Dry brewers' grain,	2	8.6	2.68	.85	1.05	8 33
Proteina,	1	10.1	2.97	.57	1.00	8 70
Damaged wheat,	1	13.1	2.26	.51	.83	6 76
Louisiana rice bran,	1	10.3	1.43	.84	1.71	5 98
Glucose refuse,	1	6.7	3.37	.09	.61	8 09
Cocoa dust,	1	7.1	2.30	.63	1.34	7 49
Broom-corn waste (stalks),	1	10.4	.87	1.86	.46	4 41
Cotton hulls,	3	10.6	.75	1.08	.18	3 06
Peanut feed,	2	10.0	1.46	.79	.23	4 52
Peanut husks,	1	13.0	.80	.48	.13	2 53
Meat meal,	1	8.0	11.21	.30	.73	27 93
Apple pomace,	2	80.5	.23	.13	.02	70
Corn cobs,	8	12.1	.50	.60	.06	1 86
Palmetto roots,	1	11.5	.54	1.38	.16	2 83
Buckwheat hulls,	1	11.9	.49	.52	.07	1 77
VII. Dairy Products.						
Buttermilk,	1	91.1	.51	.05	.04	1 31
Skim-milk,	22	90.3	.59	-	-	-
Whey,	1	93.7	.10	.07	.17	48

* See note on page 260.

C. *Analyses of Dairy Products (Per Cent.).*

	Analyses.	Solids. Maximum.	Solids. Minimum.	Solids. Average.	Fat. Maximum.	Fat. Minimum.	Fat. Average.	Curd.	Salt.	Ash.
Whole milk,	1,993	18.27	10.20	13.47	7.54	1.72	4.14	-	-	-
Skim-milk,	351	10.48	7.68	9.48	1.02	.05	.32	-	-	-
Buttermilk,	31	9.86	6.83	8.33	.38	.11	.27	-	-	-
Cream (from Cooley process),	197	32.78	18.12	26.10	25.00	10.53	17.66	-	-	.62
Cream (concentrated commercial),	2	50.12	48.71	49.41	45.37	44.33	44.85	-	-	-
Butter (salted),	38	92.89	85.35	89.21	89.05	81.43	84.34	1.18	3.69	-
Butter (fresh),	14	85.36	72.49	82.24	85.05	72.21	81.48	.76	-	-
Whole-milk cheese (Jersey),*	1	-	-	62.84	-	-	37.32	22.13	-	3.39
Whole-milk cheese,*	1	-	-	64.17	-	-	34.34	26.69	-	3.14
Cheese from milk skimmed after twelve hours' standing,*	1	-	-	62.70	-	-	27.81	30.37	-	4.52
Cheese from milk skimmed after twenty-four hours' standing,*	1	-	-	57.76	-	-	23.42	31.99	-	2.35
Cheese from milk skimmed after thirty-six hours' standing,*	1	-	-	56.05	-	-	17.67	33.24	-	5.14
Cheese from milk skimmed after forty-eight hours' standing,*	1	-	-	54.59	-	-	15.77	34.94	-	3.88
Cheese from skim-milk, with addition of buttermilk,*	1	-	-	51.62	-	-	18.35	28.63	-	4.64
Genuine oleomargarine cheese,*	1	-	-	62.10	-	-	31.66	25.94	-	4.50

* From analyses made in 1875.

Tables of the Digestibility of American Feed Stuffs.

Experiments made in the United States.

Compiled by J. B. LINDSEY.

I. Experiments with Ruminants.

II. Experiments with Swine.

Dec. 31, 1895.

TABLES OF THE DIGESTIBILITY OF AMERICAN FEED STUFFS.

I. Experiments with Ruminants.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay and Dry Coarse Fodders.								
Timothy hay (in bloom),	3	5	55.6—65.7 60	56.4—66.8 60	55.8—62.1 58	51.5—61.8 57	50.3—60.4 56	57.5—71.8 63
Timothy hay (past bloom),	5	10	47.0—61.1 53	48.4—62.3 54	37.2—56.8 47	34.6—61.1 53	38.8—50.4 45	55.6—66.9 60
Timothy hay (average all trials),	11	25	57	58	52	60	48	63
Hay of mixed grasses (medium in protein*),	1	2	-	-	49	50	40	58
Hay of mixed grasses (rich in protein),	4	14	54—62 58	- -	56—66 60	44—57 49	56—64 59	56—63 59
Rowen (mixed grasses),	1	4	- -	63—67 65	65—68 66	44—50 46	68—70 69	63—68 65
Rowen (chiefly timothy),	1	4	- -	62—67 64	62—73 66	48—51 49	66—69 68	60—65 63
Average (both samples),	-	-	-	65	66	47	68	64
Salt hay of black grass (*Juncus Gerardi*),	1	2	57—62 60	- -	57—64 60	37—46 41	62—63 63	53—59 56
High-grown salt hay (largely *Spartina juncea*),	1	2	51—55 53	- -	46—55 50	42—51 47	62—63 63	52—55 53
Branch grass (*Spartina juncea*, with *Spartina stricta*, var. *glabra*),	1	2	55—57 56	- -	48—56 52	27—36 31	61—63 62	54—55 54
Low meadow fox grass (*Spartina juncea*),	1	2	52—54 53	- -	49—53 51	17—30 24	- 57	51—52 52

Meadow, swale or swamp hay,	1	2	38—40 39	– –	30—36 33	– 44	31—37 34	– 46
Hay of vetch and oats,	1	2	58—58 58	– –	65—67 66	17—20 19	60—61 60	54—54 54
Clover and timothy hay (poorly cured),	1	2	54.3—55.3 55	– –	52—54.4 53	– 58	37.5—37.9 38	– 60
Hungarian hay,	1	2	64.3—65.8 65	65.9—66.8 66	66.8—68.5 68	– 64	– 60	66.9—67.4 67
Hay of blue-joint grass (past bloom) (*Calamagrostis Canadensis*),	1	1	40	42	37	37	57	43
Hay of blue-joint grass (bloom),	1	2	66.7—70.5 69	68.1—71.5 70	71.5—73.4 72	51.4—53.3 52	68.2—72.3 70	66.4—70.9 69
Hay of orchard grass (ten days after bloom),	1	1	54	56	58	54	59	54
Hay of orchard grass (stage not given),	1	2	57.5—60 59	– –	60—66.7 64	55.4—57.4 56	60—60.8 60	55.3—57.3 56
Average of both samples,	2	3	56	56	61	55	60	55
Hay of red top,	2	3	57.6—62.3 60	59.3—63.6 61	60.8—61.8 61	44.2—58.8 51	60.4—62.4 61	59.1—65.2 62
Dried pasture grass,	1	1	71	–	77	60	72	73
Oat straw,	1	2	49—51.7 50	50.8—53.2 52	57.2—58 58	35.5—41 38	– –	51.8—54.6 53
Barley hay,	1	4	59	62	62	41	65	63
Hay of Legumes.								
Soja bean hay,	1	2	61.9—62.7 62	– –	59.5—62.1 61	18.7—39.7 29	70.1—72.1 71	66.1—71.5 69
Peanut-vine hay,	1	2	59.5—60.2 60	– –	51.2—52.6 52	62.1—69.8 66	63—63.6 63	69.3—69.7 70

* Below 10 per cent.

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay of Legumes — Concluded.								
Cow-pea-vine hay (fair quality),	1	2	– 59	– –	41.2—44.6 43	46.4—53.7 50	63.9—65.1 65	– 71
Clover hay (late bloom, fair quality),	1	2	54.4—55.5 55	55.9—56.4 56	43.8—49 46	51.8—54.8 53	49.3—59.1 55	63.3—64.8 64
Clover hay (good quality),	1	2	50.8—53.5 52	51.6—54.3 53	46.6—49 48	40—48 43	47—52.2 49	56.8—58.9 58
White clover hay (bloom),	1	1	66	67	61	51	73	70
Scarlet clover hay (*T. incarnatum*),	2	6	56.8—65.4 62	– –	32—58.1 41	35.1—54 44	64—70 66	52—73.6 60
Alsike clover (*T. hybridum*),	2	3	61.1—64.3 62	62—65.2 63	51—58.7 53	35.1—69.3 50	64—69.2 66	66.5—74.1 71
Alfalfa (lucerne) (late bloom),	1	2	–	–	49	54	77	64
Alfalfa (lucerne) (stage not given),	1	1	–	–	43	48	69	72
Corn Fodder (partially Air Dry).								
Corn stover (whole plant),	1	4	61.1—62 62	– –	64.8—68.3 67	48.1—55.8 52	49.6—54.8 52	62.5—64.5 64
Corn stover (tops and blades),	1	2	59—60.5 60	– –	71.1—71.7 71	70.6—71.9 71	54.2—56.6 55	61.9—62.6 62
Corn stover (leaves of),	1	2	54.8—56.2 56	– –	54.3—67 61	60.6—65.4 63	43.1—68.8 56	57.1—60.6 59

Corn stalk (below ear),	1	2	64—69 67	– –	71—75 74	79—80 80	15—27 21	65—73 69
Topped stover (part above ear),	1	2	52—58 55	– –	69—72 71	62—65 64	17—27 22	50—57 54
Corn husks,	1	2	71—73 72	– –	78—81 80	23—42 33	24—35 30	75 –
Corn leaves (below ear),	1	2	62—67 65	– –	75—80 78	52—59 56	28—41 35	66—70 68
Flint corn fodder (ears just forming),	1	3	69—72 70	71—73 71	72—73 72	63—71 67	69—73 70	71—73 71
Flint (mature) field corn fodder,	4	9	68—73 71	71—75 73	69—80 76	59—77 70	59—79 65	69—78 73
Dent (mature) field corn fodder,	5	10	63—70 68	– –	43—61 54	72—82 78	43—61 53	68—81 76
Average both kinds,	–	–	70	–	65	74	59	74
Dent (in milk) field corn fodder,	5	11	58.8—66 63	– –	50—71 64	67—79 75	44—51 50	61—69 66
Dent (immature, Burrill and Whitman, coarse),	1	4	51—64 57	– –	45—74 59	66—84 76	20—36 27	57—66 61
Dent (immature, no ears formed),	4	8	61—70 65	63—71 67	63—77 71	59—72 66	57—67 62	57—70 64
Sweet corn fodder (mature),	3	6	60—71 67	62—74 70	70—77 74	63—71 74	54—73 64	57—73 68
Miscellaneous Dry Substances.								
Hay of wild oat grass (*Danthonica spicata*),	2	3	59.6—68.3 64	61.2—69.1 65	65.1—70.6 68	38.2—62.8 50	48.6—68 58	62.1—68.8 65
Hay of witch grass (*Triticum repens*),	2	4	59.9—62.7 61	61—64.3 62	56.4—67.6 62	53.6—60 57	49.5—64.2 58	62.1—69.9 66
Hay of buttercups (*Ranunculus acris*),	1	2	56	57	41	70	56	67

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Miscellaneous Dry Substances — Concluded.								
Hay of white weed (*Leucanthemum vulgare*),	1	2	58	58	46	62	58	67
Cat's-tail millet (*Pennesetum spicatum*),	1	2	61.1—63.6 62	– –	64.7—68.4 67	44.7—47.6 46	60.6—64.6 63	58.3—60 59
Johnson-grass hay,	1	1	55	–	58	39	45	54
Sorghum fodder (leaves),	1	2	59.9—66.3 63	– –	64.9—75.9 70	46.3—47.1 47	59.5—62.2 61	62.5—66.6 65
Sorghum bagasse,	1	1	61	–	64	46	14	65
Cotton-seed hulls (fed alone),	4	13	35—47.5 41	– –	.54—57.6 47	58.2—89.3 79	.00—24.6 6	12.9—45.7 34
Cotton-seed hulls when fed with cotton-seed meal (7 to 1 and 6 to 1),	1	3	41 –	– –	33—40 38	– 78	– –	48—50 49
Cotton-seed hulls when fed with cotton-seed meal (4 to 1 to 1½ to 1),	3	11	43—48 45	– –	43—50 46	66—80 76	– –	49—57 51
Cotton-seed feed (hulls and meal, 7 to 1 and 6 to 1),	1	3	45--46 46	– –	34—40 37	81—82 82	44—46 45	50—51 50
Cotton-seed feed (hulls and meal, 4 to 1 to 1½ to 1),	3	11	52—56 55	– –	43—49 46	84—86 85	61—65 62	49—56 54
Green Fodders.								
Dent corn fodder (immature),	4	11	64—74 68	– –	60—76 67	37—83 68	56—80 66	64—79 71
Dent corn fodder (in milk),	3	9	70	–	64	78	61	76

Dent corn fodder (glazing),	5	9	67	-	51	78	54	75
Dent corn fodder (mature),	2	4	65	-	55	73	51	72
Average (glazing and mature),	7	13	66	-	52	76	53	74
Dent corn fodder (ears glazing, Burrill and Whitman, coarse),	1	2	51—54 52	- -	46—47 46	74—82 78	20—28 24	87—61 59
Sweet corn fodder (milk),	1	2	77—78 77	- -	74—76 75	73—74 74	77—78 77	80—81 81
Early amber sorghum (just after blossom),	1	2	60.9—61.7 61	- -	41.7—45.3 42	67 -	37.7—42.5 40	70.4—70.8 71
Sorghum in blossom (variety not stated),	1	2	73.1—73.3 73	- -	74—75 75	81.3—81.6 81	51.1—55.7 53	78.2—78 78
Average both samples,	2	4	67	-	59	74	46	74
Green grass (young),	1	1	69	-	74	55	65	72
Same (dry),	1	1	71	-	77	60	71	73
Pasture grass,	1	2	71.9—75.6 74	- -	74.6—76.5 76	74—74.9 74	74—76.5 75	73.8—77.1 75
Average of three samples,	-	-	71	-	76	63	70	73
Soiling barley (full bloom),	1	2	- -	62—71 66	49—64 56	61—63 62	69—71 70	69—76 73
Barley and peas (full bloom),	1	2	- -	55—65 60	55—65 60	38—49 44	73—81 77	56—67 61
Soiling rye (formation of head),	1	2	73.2—74 74	- -	78.9—80.4 80	73.6—74.8 74	78 6—79.7 79	69.7—71.4 71
Hungarian grass (probably in bloom),	1	4	61—67 63	63.4—68.8 66	65.4—71.7 68	47.8—56 52	59.4—66.4 62	63.5—68.4 66
Soiling clover (late blossom),	1	2	64.9—67.3 66	- -	52.3—52.9 53	63—66.1 65	65.8—68.3 67	76.1—79.3 78

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Green Fodders — Concluded.								
Scarlet clover (late bloom),	1	3	- -	68—70 69	54—58 56	63—69 66	- 77	74—75 74
Average two samples clover,	2	5	66	67	55	66	73	77
Corn Silage.								
Dent silage (immature),	5	13	60—68 64	- -	71—78 70	64—85 71	42—65 54	60—70 66
Dent silage (milk),	4	12	60—74 65	- -	45—80 64	78—90 87	45—63 52	63—73 69
Dent silage (average of both),	9	26	65	-	68	79	53	67
Dent silage (stage uncertain, North Carolina),	1	4	53—67 60	- -	43—64 56	55—79 70	19—34 24	61—76 68
Flint silage (ears glazing),	4	11	68—78 75	66—80 77	75—79 77	- 82	48—73 65	71—83 79
Fine crushed silage (steers),	1	2	60.4—68 64	- -	72—78 75	75—77 76	32—44 38	60—70 65
Fine crushed silage (sheep),	1	2	51.5—56 54	- -	59.5—67.7 64	67.5—69 68	21—22 21.5	52.6—57.3 55
Corn silage (raw, ears mature),	1	1	-	-	59	86	45	71
Same (cooked),	1	1	-	-	70	87	39	75
Sweet corn ensilage (occasional ears mature),	1	2	66.6—69.6 68	68.5—71.7 70	68.4—73.7 71	82.3—84.6 83	52.7—55.2 54	70.7—73 72
Soja-bean ensilage,	1	2	52.2—65.8 59	- -	47.1—62.5 55	66.4—77.3 72	71.3—80.2 76	45.9—58.2 52

Roots, Tubers, etc.								
Potatoes,	1	3	73.3—80.1 77	74.6—81.2 78	– –	13 –	43.4—45.4 44	87.3—93.4 91
Sugar beets,	1	2	94.2—94.8 95	97.6—99.9 99	88.5—113 100	46.4—53.5 50	90—92.6 91	99.8—100 100
Mangolds,	1	2	77.1—80 79	82.7—87 85	26.8—58.8 43	– –	69.7—79.8 75	90.8—91.9 91
English flat turnips,	1	2	90.7—94.9 93	93.2—99 96	89.2—117 100	82.5—92.5 98	84.5—95 90	96—97 97
Ruta-bagas,	1	2	84.4—90 87	89.2—93 91	61—87.5 74	76.8—91.6 84.2	74.7—85.9 80.3	94.4—95.1 95
Grains and Seeds.								
Corn meal (maize),	2	5	83—98 88	– –	– –	80—98 92	40—77 60	85—100 93
Corn and cob meal,	1	3	74—83 79	– –	2—86 45	82—85 84	43—65 52	86—91 88
Pea meal,	1	2	85—88 87	86—89 88	25—26 26	52—57 55	80—86 83	93—94 94
Raw cotton seed,	1	2	63—69 66	– –	65—86 76	– 87	66—70 68	49—50 50
Roasted cotton seed,	1	2	53—58 56	– –	62—69 66	68—75 72	44—50 47	50—53 51
Soja-bean meal,	1	2	75—82 79	– –	28—50 50	81—90 85	89—91 90	71—73 72
Cotton-seed meal,	2	6	67—82 76	– –	– 32	87—100 93	83—96 88	44—75 64
By-products.								
Gluten meal,	1	2	85—90 87	86—92 89	– 33	86—90 88	83—90 87	88—94 91
Chicago gluten meal,	1	2	87—89 88	– –	– –	92—94 93	87—91 89	93—94 93

Table of the Digestibility of American Feed Stuffs—Concluded.

KIND OF FODDER.	Number of Different Samples	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
By-products—Concluded.								
King gluten meal,	1	2	79—82 81	- -	- -	91—97 94	- 91	78—81 79
Average gluten meals,	3	6	85	-	-	92	89	88
Buffalo gluten feed (one lot),	1	2	76—80 78	- -	40—46 43	81—82 81	84—86 85	78—84 81
Buffalo gluten feed (another lot),	1	2	87—88 87	- -	84—94 89	92—95 93	87—87 87	87—87 87
Peoria gluten feed,	1	2	84—87 86	- -	59—97 78	76—82 79	81—85 83	90—90 90
Chicago maize feed,	1	2	83—85 84	- -	68—76 72	90—90 90	83—84 84	84—87 85
Winter-wheat bran,	1	3	57—66 62	- -	00—56 27	51—80 64	75—79 77	62—76 65
Spring-wheat bran,	1	2	62—63 63	- -	22—25 24	76—76 76	78—82 80	70—71 70
Average all wheat brans,	4	9	60	63	22	71	78	68
Wheat middlings,*	1	2	72.6—72.2 75	75.1—79.3 77	- -	84.1—86.1 85	78.4—79.4 79	80.7—84.5 83
Wheat middlings,*	1	2	79.48—85.63 83	- -	32.57—40.06 36	81.71—87.98 85	81.83—87.75 85	84.43—91.08 88
New-process linseed meal,	1	3	73—83 80	- -	49—100 74	90—98 93	86—88 85	82—87 84
Old-process linseed meal,	1	3	75—82 79	- -	38—71 57	85—92 89	86—93 89	76—79 78

Atlas meal,	1	2	80—80 / 80	– / –	95—116 / 106	90—92 / 91	73—73 / 73	84—85 / 84
Rye meal,	1	2	85—90 / 87	– / –	– / –	63—65 / 64	83—85 / 84	89—94 / 92
Peanut feed,	1	2	32—32 / 32	– / –	10—13 / 12	89—90 / 90	70—71 / 71	41—58 / 49
Malt sprouts,	1	1	67	68	34	100	80	69
Dried brewers' grains,	1	2	62—62 / 62	– / –	50—55 / 53	89—93 / 91	78—81 / 79	59—59 / 59
Corn cobs,	1	2	59—60 / 59	– / –	65—66 / 65	44—56 / 50	13—22 / 17	60—60 / 60
II. Experiments with Swine.								
Maize kernels (whole),	1	1	83	83	38	46	69	89
Maize meal,	2	2	89.5—89.7 / 90	91.3—92.1 / 92	29.4—48.7 / 39	77.6—81.7 / 80	86.1—89.9 / 88	93.9—94.2 / 94
Maize meal (with cobs),	1	1	76	77	29	82	76	84
Pea meal,	1	1	90	92	78	50	89	95
Barley meal,	1	1	80	80	49	57	81	87
Wheat (whole),	1	?	72	–	30	60	70	74
Wheat (cracked),	1	?	82	–	60	70	80	83
Wheat shorts,	1	2	74—79 / 77	– / –	25—48 / 37	– / –	71—75 / 73	85.5—88 / 87
Wheat bran,	1	2	53.7—68.6 / 61	– / –	29.6—39.1 / 34	65.4—78.1 / 72	74.4—75.8 / 75	56—75 / 66

* Probably different products.

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The following publications have been consulted in compiling the tables of the digestibility of American feed stuffs: —

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REPORT OF THE CHEMIST.

DEPARTMENT OF FERTILIZERS AND FERTILIZER MATERIALS.

CHARLES A. GOESSMANN.

Part I. On Field Experiments.

1. Experiments to study the effect of raising leguminous crops in rotation with grain crops on the nitrogen sources of the soil.
2. Observations with mixed forage crops as fodder supply.
3. Experiments to study the economy of using natural phosphates in place of acid phosphates (superphosphates).
4. Experiments to ascertain the influence of different mixtures of chemical fertilizers on the character and yield of garden crops.
5. Experiments to study the effect of phosphatic slag and nitrate of soda as compared with ground bones on field crops.
6. Experiments to study the effect of rotation of manures on permanent grass lands.

Part II. On the Work in the Chemical Laboratory.

1. Report on inspection of commercial fertilizers.
2. Report on general work in the laboratory.
3. Compilation of analyses of manurial substances.
4. Compilation of analyses of fruits, garden crops and insecticides.

PART I.

REPORT ON FIELD EXPERIMENTS.

CHARLES A. GOESSMANN.

1. FIELD EXPERIMENTS CARRIED ON FOR THE PURPOSE OF STUDYING THE EFFECT OF A LIBERAL INTRODUCTION OF CLOVER-LIKE PLANTS — LEGUMINOUS CROPS — INTO FARM PRACTICE, AS A MEANS OF INCREASING THE RESOURCES OF AVAILABLE NITROGEN PLANT FOOD IN THE SOIL UNDER CULTIVATION. (*Field A.*)

The observation of the fact that the different varieties of clover and of clover-like plants in general, as peas, beans, vetches, lupines, etc., are in an exceptional degree qualified, under favorable conditions, to convert, by the aid of certain micro-organisms of the soil, the elementary nitrogen of the air into plant food, imparts to that class of farm crops a special interest from an economical standpoint. This circumstance is in a controlling degree due to the two following causes: —

First. — The nitrogen-containing soil constituents of plant food are as a rule in a high degree liable to suffer serious changes in regard to their character and fitness as well as in reference to their quantity.

Second. — Available nitrogen-furnishing manurial substances are the most costly articles of plant food in our markets.

Field experiments which propose to show by their results to what extent the cultivation of clover-like plants can be relied on as a practical and economical means for securing efficiently nitrogen plant food for the crops to be raised have

deservedly of late engaged the most careful attention of agricultural investigators.

The experiments in part described within a few subsequent pages were planned in 1883, and have been continued to the present time upon the same field, with such modification as circumstances advised.

The investigations have been divided into three periods: —

(*a*) Study of the existing soil resources of plant food, 1884 to 1889.

(*b*) Study of the effect of excluding nitrogen plant food from outside sources and of adding nitrogen plant food in various available forms, 1889 to 1892.

(*c*) Studying the effect of the cultivation of leguminous crops on the resources of available nitrogen plant food in the soil under treatment, 1892 to 1896.

The systematic treatment of the field here under consideration, as far as suitable modes of cultivation and of manuring are concerned, was introduced during the season of 1883 to 1884.

The subdivision of the entire area into eleven plats, "one-tenth of an acre each," of a uniform size and shape, 132 feet long and 33 feet wide, with an unoccupied and unmanured space of 5 feet in width between adjoining plats, has been retained unaltered since 1884. A detailed statement of the temporary aim and general management of the experiments, as well as of the results obtained in that connection from year to year, forms a prominent part of my contemporary printed annual reports, to which I have to refer for further details, 1884–95. The first four years of the stated period 1884–89 were principally devoted to an investigation into the general character and condition of the soil under cultivation, as far as its natural and inherent resources of available phosphoric acid, nitrogen and potash were concerned. *The soil proved to be in particular deficient in potash.* Different varieties of corn (maize) were raised in succession to assist in the investigation.

Since 1889 the main object of observation upon the same field has been to study the influence of an entire exclusion of any additional nitrogen-containing manurial substance

from the soil under cultivation, as well as of a definite additional supply of nitrogen in different forms of combination on the character and yield of the crop selected for the trial.

Several plats (4, 7, 9) which for five preceding years (1883 to 1889) had not received any nitrogen compound for manurial purposes were retained in that state, to study the effect of an entire exclusion of nitrogen-containing manurial substances on the crop under cultivation ; while the remaining ones received, as before, a definite amount of nitrogen in the same form in which they had received it in preceding years, namely, either as sodium nitrate (1, 2), as ammonium sulphate (5, 6, 8), as organic nitrogenous matter in form of dried blood (3, 10) or of barn-yard manure (0). A corresponding amount of available nitrogen was applied in all these cases.

PLATS.	Annual Supply of Manurial Substances.
Plat 0,	800 lbs. of barn-yard manure, 32 lbs. of potash-magnesia sulphate and 18 lbs. of dissolved bone-black.
Plat 1, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 2, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 3, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 4, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 5, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 6, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 7, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 8, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 9, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 10, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).

Amount of Fertilizing Ingredients used Annually per Acre.

Plats 0, 1, 2, 3, 5, 6, 8, 10,	Nitrogen,	45 pounds.
	Phosphoric acid,	80 pounds.
	Potassium oxide,	125 pounds.
Plats 4, 7, 9,	Nitrogen,	none.
	Phosphoric acid,	80 pounds.
	Potassium oxide,	125 pounds.

The mechanical preparation of the soil, the incorporation of the manurial substances, the seeding, cultivating and harvesting, were carried on year after year in a like manner, and as far as practicable on the same day in case of every plat during the same year.

Kind of Crops raised.

Corn (maize),	in 1889.
Oats,	in 1890.
Rye,	in 1891.
Soja bean,	in 1892.

The annual yield of the various crops upon the different plats showed that as a rule those plats (4, 7, 9) which had not received in any form nitrogen for manurial purposes yielded much smaller crops than those that annually received in some form or other an addition of a corresponding amount of available nitrogen.

The results of four years of careful observation were expressed in the following conclusion: —

The experiments carried on upon Field A during the years 1889, '90, '91 and '92 show conclusively the importance of a liberal supply to the soil of an available form of nitrogen to secure a successful and remunerative cultivation of farm crops under otherwise corresponding favorable conditions. For even a leguminous crop, the soja bean, when for the first time raised upon Field A, did not furnish an exception to our observation (1892). (For details, see report for 1892.)

Subsequent to the year 1892, when for the first time in the more recent history of the field under discussion a leguminous crop, a late-maturing variety of soja bean, had been

raised upon it, our attention had been directed chiefly to the question, To what extent does the cultivation of soja bean, a clover-like plant, benefit the resources of available nitrogen plant food of the soil after the removal of the crop at the close of the season (for ensilage)?

It seemed of interest in our case to ascertain whether the raising of the soja bean upon Field A had increased the amount of available nitrogen stored up in the soil to such an extent as to affect the yield of succeeding crops upon those plats (4, 7, 9) which, as a rule, did not receive at any time for eight successive years an addition of available nitrogen from any other manurial source but the atmospheric air and the roots left in the soil after harvesting the crops raised.

A grain crop (oats) was selected as the crop suitable to serve for that purpose. The general management of the experiment, as far as the preparation of the soil, manuring and seeding-down are concerned, was the same as in preceding years (see tenth annual report).

An examination of the yield of the crop in 1893, secured upon the different plats, showed that the total crop per acre on those plats to which no nitrogen was applied (4, 7, 9) averaged 800 pounds less than in case of the plats which received their regular supply of nitrogen in some form or other.

Ratio of Grain to Straw (1893).

Plat 0,	1:3	Plat 6,	1:4.9
Plat 1,	1:4.1	Plat 7,	1:3.6
Plat 2,	1:3.1	Plat 8,	1:3.4
Plat 3,	1:3.2	Plat 9,	1:3.4
Plat 4,	1:2.7	Plat 10,	1:3.9
Plat 5,	1:7		

The best results in relation of total yield to yield of grain were obtained in case of those plats receiving organic nitrogen (dried blood and barn-yard manure) or nitrogen in the form of nitrate of soda; while in the case of sulphate of ammonia the ratio of grain to straw was too wide to be satisfactory.

The total yield of crops on the plats receiving no nitro-

gen addition, as compared with those receiving a nitrogen supply, was during succeeding years as follows: —

With corn in 1889, one-fifth less.

With oats in 1890, one-fifth to one-sixth less.

With rye in 1891, one-fifth to one-sixth less.

With soja bean in 1892, one-third to one-fourth less.

With oats in 1893, one-seventh to one-eighth less.

From these results it appeared that the introduction of a leguminous crop into our rotation had somewhat reduced the difference in yield between the plats receiving no nitrogen and those receiving it, yet had not entirely obliterated it. It was decided to continue the observation by repeating the raising of soja beans in 1894 and oats in 1895.

1894. — To secure, if possible, more decisive results regarding the presence and absence of available nitrogen, it was decided to use twice the amount of phosphoric acid and potassium oxide, as compared with preceding years.

Amount of Fertilizing Ingredients applied per Acre during 1894.

Plats 0, 1, 2, 3, 5, 6, 8, 10,	Nitrogen,	45 pounds.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.
Plats 4, 7, 9,	Nitrogen,	none.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.

An early-maturing variety of soja bean was selected for the experiments. The fertilizer mixtures were applied as in previous years, broadcast, in the middle of April.

After proper preparation of the soil the soja beans were planted on May 12 in drills two and one-half feet apart, 6 pounds of seed being used per plat, or 60 pounds per acre. The plants appeared above ground May 21; June 5 the field was cultivated and hoed, and also on the 16th, 25th and July 12.

The plants began to bloom July 25. Owing to the protracted drought of July and August, the crop did not get that fulness of growth which might have been obtained under more favorable conditions. The crop was cut August 28.

Yield of Soja Bean when cut on Different Plats (1894).

[Pounds.]

PLATS.	Per Plat.
Plat 0,	600
Plat 1,	625
Plat 2,	700
Plat 3,	525
Plat 4,	405
Plat 5,	645
Plat 6,	615
Plat 7,	480
Plat 8,	680
Plat 9,	470
Plat 10,	570

	Per Cent.
Dry matter,	34
Moisture,	66

Conclusions.

1. A comparison of the above-stated yield of the different plats shows that those plats (4, 7, 9) which received no nitrogen addition from an outside source yielded on an average 452 pounds each, while those plats which received an addition of available nitrogen plant food, 45 pounds of nitrogen per acre, yielded on an average 620 pounds each, — a difference of one-third in favor of the latter.

2. An increase to twice the amount of phosphoric acid and potassium oxide, as compared with earlier years (see report for 1892), had not changed the relative yield of the crop, as noticed in case of the late soja bean in 1892.

1895. — Oats were again selected to succeed the soja bean of the preceding season, for the purpose of admitting a direct comparison of the results of 1894 and 1895 with those obtained under corresponding circumstances during the years 1892 and 1893, when the same crops followed each other in the same order.

The field was ploughed April 29; the fertilizers were applied April 30, in the same manner and in the same quantity to each plat as in the preceding year (1894), specified upon a previous page, namely, per acre: —

Plats 4, 7, 9,	Nitrogen,	None.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.
Plats 0, 1, 2, 3, 5, 6, 8, 10,	Nitrogen,	45 pounds.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.

The oats were sown in drills two feet apart, at the rate of 7 pounds per plat, or 70 pounds per acre, on May 7. The young plants showed above ground on all plats alike May 11.

To secure clean culture the cultivator was used twice, May 29 and June 12. The crop did not mature at the same time upon all plats, and was for that reason cut at different dates. It was cut when matured, on August 2 upon plats 0, 1, 2, 3, 4, 7, 9, 10, on August 8 upon plats 5 and 8 and on August 17 upon Plat 6. From this data it will be noticed that in all cases where sulphate of ammonia was used as the nitrogen supply for the raising of oats the maturing of the crop was from one to two weeks later than on all other plats, where either nitrate of soda or organic nitrogen compounds, as blood, barn-yard manure or no nitrogen-containing manurial matter, was applied. Similar results have been noticed in previous years, when summer grain crops have been raised in connection with the experiment under discussion.

Yield of Field A, Oats (1895).

[Pounds.]

PLATS.	Oats.	Straw.	Total Weight.
Plat 0,	134	254	388
Plat 1,	160	330	490
Plat 2,	150	330	480
Plat 3,	149	331	480
Plat 4,	110	233	343
Plat 5,	190	360	550
Plat 6,	155	405	560
Plat 7,	136	292	428
Plat 8,	92	458	550
Plat 9,	123	217	340
Plat 10,	169	381	550

	Per Cent.
Moisture, oats,	14.60
Moisture, straw,	15.90

Summary of Yield of Oats (1893, 1895).

[Pounds.]

PLATS.	1893.			1895.		
	Weight of Grain.	Weight of Straw and Chaff.	Total Weight.	Weight of Grain.	Weight of Straw and Chaff.	Total Weight.
Plat 0,	131	399	530	134	254	388
Plat 1,	135	555	690	160	330	490
Plat 2,	146	454	600	150	330	480
Plat 3,	166	534	700	149	331	480
Plat 4,	160	430	590	110	233	343
Plat 5,	79	551	630	190	360	550
Plat 6,	102	498	600	155	405	560
Plat 7,	119	431	550	136	292	428
Plat 8,	95	325	420	92	458	550
Plat 9,	110	370	480	123	217	340
Plat 10,	125	485	610	169	381	550

Ratio of Grain to Straw (1893, 1895).

PLATS.	1893.	1895.
Plat 0,	1:3	1:1.9
Plat 1,	1:4.1	1:2.06
Plat 2,	1:3.1	1:2.2
Plat 3,	1:3.2	1:2.2
Plat 4,	1:2.7	1:2.1
Plat 5,	1:7	1:1.9
Plat 6,	1:4.9	1:2.6
Plat 7,	1:3.6	1:2.14
Plat 8,	1:3.4	1:4.97
Plat 9,	1:3.4	1:1.76
Plat 10,	1:3.9	1:2.25

Average Yield of Oats on Plats receiving no Nitrogen and on Plats receiving Nitrogen (1893, 1895).

[Pounds.]

PLATS.	1893.	1895.
Plats 4, 7 and 9 (no nitrogen),	540.0	370.3
Plats 0, 1, 2, 3, 5, 6, 8 and 10 (receiving nitrogen),	597.5	506.0

Conclusions.

The conditions of the different plats are apparently materially the same to-day as they were two years ago. The raising of soja beans has not changed the results for the better. It remains to be seen whether the ploughing under of a leguminous crop, serving as green manure, will affect the results.

2. Observations with the Cultivation of Mixed Forage Crops. (*Field B.*)

The importance of a more liberal supply of nutritious forage crops for an economical support of dairy stock is quite generally recognized by all parties interested. To assist in the solution of that question induced the writer to devote for a series of years special attention to the raising of fodder crops of a high nutritive character and of a liberal yield. Mixed forage crops, consisting of early maturing annual leguminous crops, clover-like plants and of either oats or barley, suggested themselves for a trial; for they attain a high feeding value at a comparatively early period of the season, — towards the end of June when in bloom; they can serve with benefit in form of green fodder, hay or ensilage, as circumstances advise, and they yield under fair conditions large quantities. Experiments with peas, Scotch tares and vetches have been already described in previous reports. The results obtained induced the writer to prefer summer vetch (*vicia sativa*) to both peas and tares, in case of mixed crops. The fields used for the observation were located in different parts of the farm; they were as a rule in a fair state of cultivation, as far as the mechanical condition of the soil as well as its store of plant food was concerned. The soil consisted in the majority of cases of a somewhat gravelly loam.

Vetch and Oats.

1893. — Half an acre of a field which had served during the preceding year for the production of root crops, carrots and sugar beets was fertilized April 26 with 300 pounds of fine-ground bone and 100 pounds of muriate of potash. The fertilizer was applied broadcast and subsequently ploughed in May 8; the field was sown with oats and summer vetch, using 2 bushels of oats and 25 pounds of vetch. The seeds were sown each by itself, on account of the great difference in size and general character. The crop made an even and rapid growth. The oats headed out at the time when the vetch began to bloom. At this stage of growth the feeding as green fodder began, July 6. It was continued until the oats

turned yellowish, July 18. The remainder of the crop was then cut for hay. The total yield of the crop, counted as green fodder, with 20 per cent. of dry vegetable matter, amounted to 21,000 pounds per acre. Buckwheat was subsequently raised upon the same field as fall crop.

1894. — The field in this case was 700 feet long and 75 feet wide, equal to one and one-fifth acres (corn was raised upon it in 1893). It was ploughed Oct. 25, 1893, and manured with barn-yard manure at the rate of ten tons per acre; and was ploughed again April 18, 1894, and harrowed and subsequently seeded with oats and vetch, as described in the preceding experiment, using 4 bushels of oats and 45 pounds of vetch per acre. The seeds were, however, sown at two different times, to extend the period of the fitness of the crop for green fodder. The seed sown on the northern portion April 20 came up April 28. The southern portion of the field was seeded May 11, the plants appearing above ground May 19. The crop made a very satisfactory growth, and on June 23 the feeding of the green material from the northern portion began (the vetch being in bloom and the oats heading out), continuing until July 2, when the remainder was cut for hay. July 6 the cutting from the southern portion began, continuing until the 18th, when that remaining was cut for hay. Following is given a statement of the yield from the field: —

	Pounds.
Green material fed (19.12 per cent of dry matter), .	6,875
Hay of vetch and oats (73.66 per cent. of dry matter),	4,980

July 21 the field was ploughed and prepared for raising upon it, as a fall crop, Hungarian grass.

During the same year (1894) other observations of a similar character as previously described were carried on in other parts of the farm.

It was decided to compare the effect of muriate of potash and sulphate of potash on mixed crops, consisting of oats and vetch and of barley and vetch. The field used for this observation consisted of a light loam. It had been used during the preceding season for the cultivation of different varieties of potatoes, and had received as manure on that occasion, per acre, in one case, 400 pounds of high-grade

sulphate of potash (95 per cent.), with 600 pounds of fine-ground bone; in the other, 400 pounds of muriate of potash (80–82 per cent.), with 600 pounds of fine-ground bone. The same amount and kind of manure were applied for raising vetch and oats and vetch and barley. The field occupied by these crops was ploughed, manured, harrowed and seeded down, as far as practicable, at the same time. The seed was sown in all cases April 26. Four bushels of oats with 45 pounds of vetch were sown, as on previous occasions, while 3 bushels of barley were used, with 45 pounds of vetch, in case of barley and vetch. Both crops came up May 4, and were of a uniformly healthy condition during their subsequent growth. The barley began to head out June 20; the vetch was at that time beginning to bloom. The crop was cut for hay June 23.

Yield of Barley and Vetch per Acre.

In case of muriate of potash and bone, . .	5,737 pounds of hay.
In case of sulphate of potash and bone, . .	5,077 pounds of hay.

The oats headed out June 25; the vetch was fairly in bloom. The crop was cut for hay July 2.

Yield of Oats and Vetch per Acre.

In case of muriate of potash and bone, . .	8,051 pounds of hay.
In case of sulphate of potash and bone, . .	7,088 pounds of hay.

1895. — During that year the observations of the preceding year were repeated and in some directions enlarged upon. Aside from mixed forage crops of vetch and oats and vetch and barley, there were raised crops consisting of oats, vetch and horse bean and of oats and lentils. The field used for these experiments had been used during the preceding season either for the cultivation of potatoes or of vetch and oats. In both cases it had been manured, per acre, with either 400 pounds of muriate of potash and 600 pounds of fine-ground bone, or with 400 pounds of sulphate of potash and 600 pounds of fine-ground bone. The same kind and the same quantity of manure were applied in 1895. The field was ploughed April 25; the manure harrowed in

May 3; the seed was sown broadcast May 9. All parts of the field were treated alike, and as far as practicable on the same day. The plats occupied by the crops were in all cases 33 feet wide, with 4 feet unoccupied space between them, and from 191 to 241 feet long. The yield of areas 175 feet long and 33 feet wide, running along by the side of each other, served as our basis for comparing results (5,775 square feet).

The seed was sown May 9, at the rate of 4 bushels of oats and 45 pounds of vetch per acre. The oats came up May 16, and the vetch May 21; the former headed out July 6, and the vetch began blooming at that time. The crop was cut for hay July 16.

Yield of Vetch and Oats per Acre.

In case of muriate of potash and bone, ...	7,238 pounds.
In case of sulphate of potash and bone, ...	6,635 pounds.

Vetch, Horse Bean and Oats.

The seed was sown May 9, at the rate of 40 pounds of vetch, 120 pounds of horse bean (medium sized) and 3 bushels of oats. The oats came up May 16, the vetch on May 21 and the horse bean May 23. The crop appeared healthy and vigorous at every stage of growth. It was cut for hay July 22, when the oats were fairly headed and the remainder in bloom.

Yield of Vetch, Horse Bean and Oats per Acre.

In case of muriate of potash and bone, ...	7,398 pounds.
In case of sulphate of potash and bone, ...	5,881 pounds.

Lentils and Oats.

The seed was sown May 9, at the rate of 60 pounds of lentils and 4 bushels of oats per acre. The oats came up May 16, and the lentils on May 21; the former headed out July 6, when the latter were fairly in bloom. The crop was cut for hay July 16. The experiment was confined to a trial with sulphate of potash and bone as manure on account of want of a suitable field.

Yield of lentils and oats per acre, ... 5,881 pounds of hay.

Composition of Mixed Forage Crops raised, 1893 to 1896.

Green crop when cut contains: —

Moisture, ...	76 to 80 per cent.
Dry matter, ...	20 to 24 per cent.

Analyses of Vetch and Barley (Equal Number of Plants of Each).

[Per Cent.]

	Muriate of Potash.	Sulphate of Potash.
Moisture at 100° C., ...	78.23	77.70
Dry matter, ...	21.77	22.30
	100.00	100.00
Analysis of Dry Matter.		
Crude ash, ...	4.64	7.80
" fibre, ...	32.25	32.58
" fat, ...	2.12	2.56
" protein, ...	14.44	13.36
Nitrogen-free extract matter, ...	46.55	43.70
	100.00	100.00

Analyses of Vetch and Oats (Equal Number of Plants of Each).

[Per Cent.]

	Muriate of Potash.	Sulphate of Potash.
Moisture at 100° C., ...	76.24	75.29
Dry matter, ...	23.76	24.71
	100.00	100.00
Analysis of Dry Matter.		
Crude ash, ...	9.59	8.69
" fibre, ...	29.83	31.28
" fat, ...	3.13	2.63
" protein, ...	18.88	15.16
Nitrogen-free extract matter, ...	38.57	42.24
	100.00	100.00

Analysis of Vetch, Oats and Horse Bean (Muriate of Potash).

[Three plants each of vetch and of oats and one of horse bean.]

	Per Cent.
Moisture at 100° C.,	82.13
Dry matter,	17.87
	100.00

Analysis of Dry Matter.

Crude ash,	10.36
" cellulose,	30.07
" fat,	2.70
" protein,	18.93
Nitrogen-free extract matter,	37.94
	100.00

Analysis of Lentils and Oats.

	Per Cent.
Moisture at 100° C.,	78.50
Dry matter,	21.50
	100.00

Analysis of Dry Matter.

Crude ash,	5.40
" cellulose,	34.90
" fat,	2.40
" protein,	14.90
Nitrogen-free extract matter,	42.40
	100.00

Conclusions.

From the above analyses it appears that vetch and oats lead vetch and barley, on account of the larger and more foliaceous character of the oats as compared with the barley. Vetch, oats and horse bean lead in nitrogenous matter, and no doubt will exceed in regard to the nutritious character of the crop as soon as the amount of horse bean has been doubled, as indicated above. Every one of these crops compares well with clover hay, as far as its nutritive value is concerned. The large yield of these crops per acre, their high nutritive value and special adaptation for green fodder, hay or ensilage, merit serious attention for the support of farm and dairy stock. The early date of maturity presents exceptionally good chances of raising a second crop for fall supply of fodder, or for a timely preparation of the soil for winter crops. Feeding experiments carried on for several years at the station with these crops have fully established their high nutritive character for dairy stock, as well as other farm live stock ordinarily depending on the product of the meadow and pasture.

3. Field Experiments with Different Commercial Phosphates, to study the Economy of using the Cheaper Natural Phosphates or the More Costly Acidulated Phosphates. (*Field F.*)

The field selected for this purpose is 300 feet long and 137 feet wide, running on a level from east to west. Previous to 1887 it was used as a meadow, which was well worn out at that time, yielding but a scanty crop of English hay. During the autumn of 1887 the sod was turned under and left in that state over winter. It was decided to prepare the field for special experiments with phosphoric acid by a systematic exhaustion of its inherent resources of plant food. For this reason no manurial matter of any description was applied during the years 1887, 1888 and 1889.

The soil, a fair, sandy loam, was carefully prepared every year by ploughing during the fall and in the spring, to improve its mechanical condition to the full extent of existing circumstances. During the same period a crop was raised every year. These crops were selected, as far as practicable, with a view to exhaust the supply of phosphoric acid in particular. Corn, Hungarian grass and leguminous crops (cow-pea, vetch and serradella) followed each other in the order stated.

1890. — The field was subdivided into five plats, running from east to west, each 21 feet wide, with a space of 8 feet between adjoining plats. The manurial material applied to each of these five plats contained, in every instance, the same form and the same quantity of potassium oxide and of nitrogen, while the phosphoric acid was furnished in each case in the form of a different commercial phosphoric-acid-containing article, namely, phosphatic slag, Mona guano, Florida phosphate, South Carolina phosphate (floats) and dissolved bone-black. The market cost of each of these articles controlled the quantity applied, for each plat received the same money value in its particular kind of phosphate. The phosphatic slag, Mona guano, South Carolina phosphate and Florida phosphate were applied at the rate of 850 pounds per acre, dissolved bone-black at the rate of 500 pounds per acre. Nitrate of soda was applied at the rate of 250 pounds

per acre and potash-magnesia sulphate at the rate of 390 pounds per acre.

Cost per Ton.

Phosphatic slag,	$15 00
Mona guano (West Indies),	15 00
Florida rock phosphate,	15 00
South Carolina phosphate (floats),	15 00
Dissolved bone-black,	25 00

Analyses of Phosphates used.

[I., phosphatic slag; II., Mona guano; III., Florida phosphate; IV., South Carolina phosphate; V., dissolved bone-black.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture,	0.47	12.52	2.53	0.39	15.96
Ash,	–	75.99	89.52	–	61.46
Calcium oxide,	46.47	37.49	17.89	46.76	–
Magnesium oxide,	5.05	–	–	–	–
Ferric and aluminic oxides,	14.35	–	14.25	5.78	–
Total phosphoric acid,	19.04	21.88	21.72	27.57	15.82
Soluble phosphoric acid,	–	–	–	–	12.65
Reverted phosphoric acid,	–	7.55	–	4.27	2.52
Insoluble phosphoric acid,	–	14.33	–	23.30	0.65
Insoluble matter,	4.39	2.45	30.50	9.04	6.26

The following fertilizer mixtures have been applied annually, from 1890 to 1894, to all the plats, with the exception of Plat 3, which received in 1890 ground apatite and in 1891 no phosphate whatever, on account of the failure of securing in time apatite suitable for the trial.

Plats.	Annual Supply of Manurial Substances.	Pounds.
Plat 1 (south, 6,494 square feet),	Ground phosphatic slag,	127
	Nitrate of soda,	43
	Potash-magnesia sulphate,	58
Plat 2 (6,565 square feet),	Ground Mona guano,	128
	Nitrate of soda,	43½
	Potash-magnesia sulphate,	59
Plat 3 (6,636 square feet),	Ground Florida phosphate,	129
	Nitrate of soda,	44
	Potash-magnesia sulphate,	59
Plat 4 (6,707 square feet),	South Carolina phosphate,	131
	Nitrate of soda,	44½
	Potash-magnesia sulphate,	60
Plat 5 (6,778 square feet),	Dissolved bone-black,	78
	Nitrate of soda,	45
	Potash-magnesia sulphate,	61

The field was ploughed as a rule during the month of October, and again at the close of the month of April. The fertilizer was in each case applied broadcast soon after ploughing in the spring. The seed was sown in hills or drills, as circumstances advised, and the crop kept clean from weeds by the use of the hoe or the cultivator. The following crops were raised: —

1890, potatoes (see eighth annual report).
1891, winter wheat (see ninth annual report).
1892, serradella (see tenth annual report).
1893, Dent corn, Pride of the North (see eleventh annual report).

Summary of Yield of Crops (Pounds).

PLATS.	1890. Potatoes.	1891. Wheat.	1892. Serradella.	1893. Corn.
Plat 1, phosphatic slag,	1,690	380	4,070	1,660
Plat 2, Mona guano,	1,415	340	3,410	1,381
Plat 3, Florida phosphate,	1,500	215	2,750	1,347
Plat 4, South Carolina floats,	1,830	380	3,110	1,469
Plat 5, dissolved bone-black,	2,120	405	2,920	1,322

Having for four years (1890–94) in succession pursued the above-stated system of manuring each plat with a different kind of phosphate, yet of corresponding money value, it was decided to continue the experiments for the purpose of studying the after-effect of the different phosphates on the crops to be raised. To gain this end the phosphates were hereafter in all cases entirely excluded from the fertilizers applied; in addition to this change, the former amount of potash and nitrogen was increased one-half in quantity, to favor the highest effect of the stored-up phosphoric acid of the soil under treatment.

The fertilizers hereafter to be used had the following composition: —

Plat 1 (6,494 square feet),	64½ pounds of nitrate of soda. 87 pounds of potash-magnesia sulphate.
Plat 2 (6,565 square feet),	65¼ pounds of nitrate of soda. 88 pounds of potash-magnesia sulphate.
Plat 3 (6,636 square feet),	66 pounds of nitrate of soda. 89 pounds of potash-magnesia sulphate.
Plat 4 (6,707 square feet),	66¾ pounds of nitrate of soda. 90 pounds of potash-magnesia sulphate.
Plat 5 (6,778 square feet),	67½ pounds of nitrate of soda. 90½ pounds of potash-magnesia sulphate.

The results of two seasons (1894 and 1895) are as follows: —

Barley.

Yield of Crop (1894).

Plats.	Grain and Straw (Pounds).	Grain (Pounds).	Straw and Chaff (Pounds).	Percentage of Grain.	Percentage of Straw.
Plat 1, ...	490	169	221	34.49	65.51
Plat 2, ...	405	148	251	34.07	65.93
Plat 3, ...	290	78	212	26.89	73.11
Plat 4, ...	460	144	216	31.30	68.70
Plat 5, ...	390	118	272	30.26	69.74

Rye.

Yield of Crop (1895).

Plats.	Grain and Straw (Pounds).	Grain (Pounds).	Straw and Chaff (Pounds).	Percentage of Grain.	Percentage of Straw.
Plat 1, ...	695	195	500	28.06	71.94
Plat 2, ...	631	166	465	26.31	73.69
Plat 3, ...	383	143	240	37.34	62.66
Plat 4, ...	759	189	570	24.90	75.10
Plat 5, ...	625	185	440	29.60	70.40

Summary of Yield of Crop (1890 to 1896).

[Pounds.]

Plats.	**1890.** Potatoes.	**1891.** Wheat.	**1892.** Serradella.	**1893.** Corn.	**1894.** Barley.	**1895.** Rye.
Plat 1, ...	1,600	380	4,070	1,660	490	695
Plat 2, ...	1,415	340	3,410	1,381	405	630
Plat 3, ...	1,500	215	2,750	1,347	290	383
Plat 4, ...	1,830	380	3,110	1,469	460	759
Plat 5, ...	2,120	405	2,920	1,322	390	625

Conclusions.

From the previous statement of comparative yield we find that the plat receiving dissolved bone-black leads in yield during the two first years, while for the third, fourth, fifth and sixth years the plats receiving insoluble phosphates are ahead, phosphatic slag being first, South Carolina floats second and Mona guano third.

The following statement regarding the amount of phosphoric acid applied in the case of each plat, and also the amount removed from them by the crops raised, shows approximately how much of the former is still stored up in the soil in each plat.

Phosphoric Acid applied to and removed from Field (Pounds).

PLATS.	1890. Potatoes.		1891. Wheat.		1892. Serradella.		1893. Corn.		Total Amount added.	Total Amount removed.	Total Amount remaining.
	Added.	Removed.	Added.	Removed.	Added.	Removed.	Added.	Removed.			
Plat 1, .	24.18	2.56	24.18	1.23	24.18	8.95	24.18	7.20	96.72	19.94	77.78
Plat 2, .	28.01	2.36	28.01	1.19	28.01	7.50	28.01	6.33	72.04	17.38	54.66
Plat 3, .	109.68	2.40	–	.69	28.01	6.05	28.01	5.95	165.70	15.09	150.61
Plat 4, .	36.12	2.93	36.12	1.31	36.12	6.84	36.12	6.68	144.48	18.12	126.36
Plat 5, .	12.34	3.39	12.34	1.22	12.34	6.42	12.34	6.05	49.36	17.08	32.28

Phosphoric Acid applied to and removed from Field (Pounds) — Concluded.

PLATS.	1894. — Barley.		1895. — Rye.		Total Amount added.	Total Amount removed.	Total Amount remaining.
	Added.	Removed.	Added.	Removed.			
Plat 1, ...	None.	1.92	None.	3.41	96.72	25.27	72.45
Plat 2, ...		1.64		3.04	72.04	22.06	49.98
Plat 3, ...		.76		2.06	165.70	17.91	147.79
Plat 4, ...		1.72		3.61	144.48	23.45	121.03
Plat 5, ...		1.49		3.11	49.36	21.68	27.68

The amount of phosphoric acid left in the soil at the close of the season of 1895 is lowest in Plat 5, where dissolved bone-black, the most costly phosphate used in the experiment, has served as its source. The experiment will be continued until a final answer is obtained.

4. Field Experiments to ascertain the Influence of Different Mixtures of Commercial Fertilizers on the Yield and General Character of Several Prominent Garden Crops.

The area devoted to the above-stated experiment is 198 feet long and 183 feet wide; it is subdivided into six plats of uniform size ($89\frac{1}{2}$ by 62 feet, or about one-eighth of an acre each). The plats are separated from each other and from the adjoining cultivated fields by a space of 5 feet of unmanured and unseeded yet cultivated land. They are arranged in two parallel rows, running from west to east. Nos. 1, 2 and 3 are along the north side of the field, beginning with No. 1 at its west end, while plats Nos. 4, 5 and 6 are located along its south side, beginning with Plat 4 on the west end. The soil is several feet deep, and consists of a light, somewhat gravelly loam, and was in a fair state of productiveness when assigned for the experiment here under consideration. The entire field occupied by the experiment is nearly on a level. Potatoes and a variety of forage crops had been raised upon it in preceding years. The manure applied since 1885 has consisted exclusively of fine-ground bone and muriate of potash, annually, 600 pounds of the former and 200 pounds of the latter per acre.

The observation with raising garden crops, by the aid of different mixtures of commercial manurial substances, here under special consideration, began upon plats Nos. 4, 5 and 6 during the spring of 1891, and upon plats 1, 2 and 3 during that of 1892.

The difference of the fertilizers applied consisted in the circumstance that different forms of nitrogen and potash were used for their preparation. All plats received essentially the same quantity of nitrogen, potash and phosphoric acid, and every one of them received its phosphoric acid in the same form, namely, dissolved bone-black. Some plats received their nitrogen supply in the form of organic animal matter, dried blood; others in the form of sodium nitrate, Chili saltpetre; others in the form of ammonium sulphate. Some plats received their potash in the form of muriate of potash (plats 1, 2, 3), and others (plats 4, 5, 6) in the form of the

highest grade of potassium sulphate (95 per cent.). The subsequent tabular statement shows the quantities of manurial substances applied to the different plats: —

PLATS.	Annual Supply of Manurial Substances.	Pounds.
Plat 1,	Sulphate of ammonia,	38
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 2,	Nitrate of soda,	47
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 3,	Dried blood,	75
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 4,	Sulphate of ammonia,	38
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 5,	Nitrate of soda,	47
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 6,	Dried blood,	75
	Sulphate of potash,	30
	Dissolved bone-black,	40

This proportion corresponds per acre to: —

	Pounds.
Phosphoric acid (available),	50.4
Nitrogen,	60.0
Potassium oxide,	120.0

A computation of the results of a chemical analysis of twenty prominent garden crops shows the following average relative proportion of the three above-stated ingredients of plant food: —

	Per Cent.
Nitrogen,	2.2
Potassium oxide,	2.0
Phosphoric acid,	1.0

One thousand pounds of green garden vegetables contain, on the above-stated basis of relative proportion of essential constituents of plant food: —

	Pounds.
Nitrogen,	4.1
Potassium oxide,	3.9
Phosphoric acid,	1.9

The weights and particular stage of growth of the vegetables when harvested control, under otherwise corresponding conditions, the actual consumption of each of these articles of plant food. Our information regarding these points is still too fragmentary to enable a more detailed statement

here beyond relative proportions. It must suffice for the present to call attention to the fact that a liberal manuring within reasonable limits pays, as a rule, better than a scanty one, especially in the case of those crops which reach in a short period the desired state of maturity. The various mixtures of fertilizers used by me in the experiments under discussion provide by actual supply for one-half of the available nitrogen actually called for to meet the demand as above pointed out. A liberal cultivation of peas and beans cannot fail to benefit the nitrogen resources of the soil. The order of arrangement of the different crops within each plat was the same in all of them for the same year. They occupied, however, a different position relative to each other in successive years, to introduce, as far as practicable, a system of rotation of crops.

Order of arrangement of crops in plats : —

Celery.
Lettuce.
Spinach.
Beets.
Cabbages.
Tomatoes.
Potatoes.

Spinach.
Celery.
Lettuce.
Red Cabbage.
Beets.
Potatoes.
Beets.
White Cabbage.
Tomatoes.

Potatoes.
Beans.
Tomatoes.
Spinach.
Lettuce.
Onions.

Onions.
Corn.
Beans.
Tomatoes.

The results of the stated three years were summed up as follows in my annual report for 1894, to which I have to refer for details. From our observations extending over three years we arrived at the following conclusions: —

Potash in the form of sulphate has given the most satisfactory results, as compared with muriate, in the case of potatoes, tomatoes, lettuce and spinach, and with onions during the present season.

Nitrogen in the form of nitrate of soda has given us, without regard to the potash source, the most satisfactory returns in case of spinach, lettuce, potatoes and tomatoes, and onions during the present season.

1895. — During the last season my observations have been confined to the cultivation of

Onions (Danvers Yellow).
Sweet Corn (Crosby Early).
Beans (Bush Horticultural).
Tomatoes (Essex Hybrid).

The different plats were ploughed April 20, and the particular fertilizer applied broadcast April 25. The soil was subsequently carefully prepared by harrowing, etc., for seeding and planting. The tomato plants were raised under glass and transplanted into the field when of a suitable size, May 25. The remaining crops were seeded directly in the field, — the onions May 1, the corn and the beans May 11.

The former division of the field into six plats, each containing the same crop for trial, — onions, beans, sweet corn and tomatoes, — was continued; each plat received the same mixture of fertilizing ingredients, and in the same proportion, as in the preceding years: —

	Pounds.
Available phosphoric acid,	50
Available nitrogen,	60
Available potassium oxide,	120

As each of the six plats measured $89\frac{1}{2}$ by 62 feet, covering thus an area of 5,549 square feet, or about 100 square feet more than one-eighth of one acre, the following amount of each of the above-stated essential constituents of plant food was added to each of them: —

	Pounds.
Phosphoric acid,	$7\frac{1}{2}$
Potassium oxide,	15
Nitrogen,	$6\frac{1}{4}$

The crops were planted across each plat, from north to south, in rows 62 feet in length; a corresponding number of rows of each crop was planted in each plat, and they were arranged in each case in the same order of succession, beginning on the west end: —

Onions (Danvers Yellow), eight rows.
Sweet corn (Crosby Early), four rows.
Beans (Bush Horticultural), nine rows.
Tomatoes (Essex Hybrid), two rows.

Onions.

The onions were sown in rows 14 inches apart May 1; they came up May 12. The young plants looked least satisfactory upon plats 1 and 4, and most promising upon plats 2 and 5, July 11. The crop was harvested on all plats October 5. Plats 2 and 5 yielded more than one-half of the entire marketable crop, while plats 1 and 5 yielded but one-fifteenth of it.

Yield of Onions (Pounds).

PLATS.	Marketable.	Small.	Scullions.	Total.
Plat 1,	None.	30	100	130
Plat 2,	630	165	10	805
Plat 3,	375	70	80	525
Plat 4,	125	180	65	370
Plat 5,	455	190	16	661
Plat 6,	390	52	90	532

Sweet Corn.

The corn was planted in rows 3 feet 3 inches apart, with 20 inches in the row, averaging 131 hills in each plat, May 11. The young plants came up May 27 quite uniformly on all plats.

July 11 the crop on Plat 1 looked lighter than on any of the rest. The canes were reduced to three in each hill before heading, and the tops removed after the ears were fully developed, to hasten on maturing of the crop. There is a marked difference in the results as far as Plat 1 is concerned, — organic nitrogen gives the highest results ; in case of different forms of potash, Plat 3 and Plat 6.

Yield of Sweet Corn when husked (Pounds).

PLATS.	Ears.	Husks.	Stover with Tops.	Total Weight.
Plat 1, ...	98	10	95	203
Plat 2, ...	117	8	115	240
Plat 3, ...	125	11	137	273
Plat 4, ...	112	10	125	247
Plat 5, ...	103	8	112	223
Plat 6, ...	118	10	130	258

Moisture in ears 34 per cent., in stover 20 per cent., when weighed.

Beans.

The beans were planted in rows 3 feet 3 inches apart May 11. They came up May 29 and blossomed July 6. At that time the crop looked best on Plat 5. The beans were harvested on all plats August 13, stacked on poles for drying, and were threshed in October.

Yield of Beans (Pounds).

PLATS.	Beans.	Pods and Vines.	Total Weight.
Plat 1, ...	81	260	341
Plat 2, ...	105	200	305
Plat 3, ...	83	155	238
Plat 4, ...	115	210	325
Plat 5, ...	135	260	395
Plat 6, ...	95	175	270

Tomatoes (Essex Hybrid).

The tomato plants were started under glass and transplanted in the field when from seven to eight inches high, May 25. They were of a vigorous growth, and were placed four feet apart each way. Each plat was planted with two rows, each row containing twenty-one plants. They began blooming June 5, and looked healthy at that time in all plats, yet best in Plat 5. The yield of matured tomatoes in case of plats 4 and 5 exceeded that of plats 3 and 6 by fully one-third in weight. The total yield of the crop, on account of more favorable weather of the past season, as compared with that of 1894, exceeded the latter by more than one-half of its weight.

Yield of Tomatoes (Pounds).

[Forty-two plants in each plat.]

Date of Picking.	Plat 1.	Plat 2.	Plat 3.	Plat 4.	Plat 5.	Plat 6.	Total.
August 13,	10	11	12	18	5	19	75
August 16,	85	79	125	87	57	134	567
August 20,	100	109	101	136	115	116	677
August 23,	115	134	90	150	143	86	718
August 28,	50	122	77	102	116	110	577
September 3,	151	153	133	215	210	124	986
September 11,	70	80	40	127	164	43	524
September 20,	138	40	–	63	96	–	337
September 25,	28	93	–	33	90	–	244

Yield of Green Tomatoes left October 1 (Pounds).

Plat 1,	30
Plat 2,	52
Plat 3,	26
Plat 4,	54
Plat 5,	48
Plat 6,	24
Total,	234

Summary of Yield of Garden Crops raised under Corresponding Conditions from 1891 to 1896.

Spinach (Variety New Zealand).

[Pounds.]

PLATS.	1892.	1893.	1894.	Total.	Average per Year.
Plat 1 (two rows, 62 feet long), .	192	167½	101	460	153.3
Plat 2 (two rows, 62 feet long), .	233	182	216	631	210.5
Plat 3 (two rows, 62 feet long), .	202	180½	165	547	182.3
Plat 4 (two rows, 62 feet long), .	230	196	161¾	587	195.7
Plat 5 (two rows, 62 feet long), .	232	210	253	695	231.7
Plat 6 (two rows, 62 feet long), .	134	198½	113¾	446	148.7

Lettuce (Variety Hanson).

[Pounds.]

PLATS.	1892.	1893.	1894.	Total.	Average per Year.
Plat 1 (one row, 70 plants), .	41½	40½	29	111	37.0
Plat 2 (one row, 70 plants), .	36	42	52	130	43.3
Plat 3 (one row, 70 plants), .	43	46	36	125	41.7
Plat 4 (one row, 70 plants), .	76	62	50	188	62.7
Plat 5 (one row, 70 plants), .	60	70	68	198	66.0
Plat 6 (one row, 70 plants), .	36	55	33	124	41.3

Tomatoes (Variety Essex Hybrid).

[Pounds.]

PLATS.	1892.	1893.	1894.	1895.	Total.	Average per Year.
Plat 1 (two rows, 42 plants),	464	363	352	747	1,926	481.5
Plat 2 (two rows, 42 plants),	572	874½	559	821	2,826	706.5
Plat 3 (two rows, 42 plants),	466	807	458	578	2,309	577.3
Plat 4 (two rows, 42 plants),	515	818	604	931	2,868	717.0
Plat 5 (two rows, 42 plants),	593	978½	594	996	3,161	790.2
Plat 6 (two rows, 42 plants),	332	515	571	632	2,050	502.5

Beans (Bush Horticultural).

[Pounds.]

PLATS.	1894.	1895.	Total.	Average per Year.
Plat 1 (six rows),	45	54.0	99.0	49.5
Plat 2 (six rows),	32	70.0	102.0	50.1
Plat 3 (six rows),	41	55.5	96.5	48.2
Plat 4 (six rows),	20	67.7	87.7	43.8
Plat 5 (six rows),	37	90.0	127.0	63.5
Plat 6 (six rows),	49	63.3	112.3	56.1

Onions (Danvers Yellow Globe).

[Pounds.]

PLATS.	1894.	1895.	Total.	Average per Year.
Plat 1 (four rows),	156	65.0	221.0	110.5
Plat 2 (four rows),	249	402.5	651.5	325.7
Plat 3 (four rows),	251	262.5	513.5	256.7
Plat 4 (four rows),	256	185.0	441.0	220.5
Plat 5 (four rows),	266	330.5	596.5	298.3
Plat 6 (four rows),	204	265.5	469.5	234.8

Conclusions.

1. Sulphate of potash in connection with nitrate of soda (Plat 5) has given in every case but one (onions) the best results.

2. Nitrate of soda as nitrogen source (plats 2 and 5) has yielded in every case, without reference to the form of potash, the best returns.

3. Sulphate of ammonia as nitrogen source, in connection with muriate of potash as potash source (Plat 1), has given as a rule the least satisfactory returns.

4. The influence of the difference in the general character of the weather, whether normal or dry, during succeeding seasons on the yield of the crops has been greater than that of the different fertilizers used upon different plats during the same season.

5. Field Experiments to study the Effect of Phosphatic Slag and Nitrate of Soda, as compared with Ground Bone, on the Yield of Oats and Corn.

The field used for this experiment is situated along a gently sloping ground, in the south-east corner of the farm. The soil consists of a sandy loam, and has been for several years under a careful system of cultivation and manuring. The productiveness was considered of uniform character when the experiment was planned in 1893. The area engaged in the observation was divided into two plats running along the slope from north to south. One plat, situated along the east side of the field, measured one acre (Plat 1); Plat 2 was situated along the west side of the field and measured one and nine-tenth acres.

Plat 1 was fertilized with 600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre; Plat 2 was fertilized with 800 pounds of fine-ground phosphatic slag (odorless phosphate), 200 pounds of muriate of potash and 200 pounds of nitrate of soda per acre.

The amounts of manurial ingredients used per acre correspond to (in pounds): —

	Plat 1 (Bone).	Plat 2 (Phosphatic Slag).
Potassium oxide,	104	104
Phosphoric acid,	131	166
Nitrogen,	24	31

Composition of Fertilizer applied (Per Cent.).

	Nitrogen.	Phosphoric Acid.	Potassium Oxide.
Ground bone,	4.09	21.86	–
Phosphatic slag,	–	20.84	–
Muriate of potash,	–	–	52.20
Nitrate of soda,	15.70	–	–

Cost of Fertilizer (1894).

Plat 1, bone and muriate of potash (per acre), $12.40.
Plat 2, phosphatic slag, muriate of potash and nitrate of soda (per acre), $15.70.

1894. — As the east side of the field was on a higher level than the west side, it was decided to run the crop across the two plats from east to west, to secure as far as practicable corresponding conditions of the layout of the area occupied by the crops. The northern half of the field thus divided (plats 1 and 2) measured one acre, the southern half one and nine-tenths acres.

Oats and corn (variety Pride of the North) were selected for our observations. The oats were sown broadcast, at the rate of 4 bushels per acre, upon the northern portion of the field, and the corn was planted in rows 3 feet 3 inches apart, with hills 20 inches from each other, upon the southern portion, using 12 quarts of seed corn per acre. The area occupied by oats amounted to .35 of an acre of Plat 1 and .65 of an acre of Plat 2; while the corn occupied .7 of an acre of Plat 1 and 1.2 acres of Plat 2.

Summary of Yield (1894).

[Pounds per Acre.]

	Plat 1 (Bone, etc.).	Plat 2 (Odorless Phosphate, etc.).
Oats, grain,	531	876
Oats, straw,	1,640	2,385
Corn, for ensilage,	16,294	20,608

To test the reliability of the results obtained, it was decided to repeat the experiments above described upon the same field. The fertilizers were used in the same proportion and in the same quantity per acre; they were applied upon the same portion of the field which had received each kind before. Oats and corn were again selected as crops for the trial. The material change in the experiment consisted in reversing the location of the crops; the corn was planted at

the north end of the field, where the oats had been raised during the preceding season, and the oats were raised at the south end of the field, the part previously occupied by the corn. The oats were cut for hay when well headed out, and the corn when fully matured, for grain and stover.

Summary of Yield (1895).

[Pounds per Acre.]

	Bone and Muriate of Potash.	Phosphatic Slag, Nitrate of Soda, Muriate of Potash.
Oats, hay,	3,580	5,134
Corn, ears,*	3,410	4,231
Corn, stover †	2,900	3,091

* Moisture, 28 per cent. † Moisture, 19.1 per cent. when harvested.

Conclusions.

The difference in the yield of oats and corn for two succeeding seasons points in the same direction; namely, phosphatic slag used in connection with nitrate of soda is a very efficient substitute for ground bone. To what extent these results, in our case, have to be ascribed to the presence of an excess of lime in the phosphatic slag, as compared with ground bone, is to be determined by a future actual trial.

6. Experiments with a Rotation of Manures upon Permanent Grass Lands, Meadows and Pastures.

One of the many advantages derived from the introduction of commercial fertilizers and chemicals for manurial purposes into general farm practice consists in the circumstance that in many instances a change with reference to the general character of the manure applied has served efficaciously as a substitute for a change of crops. The improved chances in compounding the manures to suit special requirements of soil and crops have, to say the least, greatly modified current views regarding the desirability or necessity of a rotation of crops in the interest of economy. The beneficial results noticed in other connections, due to a change in the general character of the manurial substances used, in case of the same land and in connection with the same crops, caused the arrangement of the experiments described upon a few subsequent pages.

Permanent grass lands are apt to suffer in the course of time from an accumulation of half-decayed vegetable matter, which is liable sooner or later to interfere with a healthy growth. To counteract this tendency it was decided to manure meadows alternately by top-dressing with barn-yard manure, or bone and muriate of potash, or wood ashes. The liberal amount of carbonate of lime, from 30 to 40 per cent., contained in the current supply of unleached wood ashes, was to serve as the means to hasten on the decomposition of the accumulating vegetable matter, and thereby secure favorable conditions for a healthy growth of valuable forage plants.

The meadows under consideration comprise an area of about 9.6 acres. The entire field up to 1886 consisted of old, worn-out grass lands, overrun with a worthless growth on its more elevated portion and covered with weeds and sedges in its lower swampy portion. The improvement of the land by underdraining was commenced in 1886 and continued during the succeeding year. For details of the work, see ninth and tenth annual reports (1891–92).

In the spring of 1893 a change was made in the mode of manuring of the grass plats. It was decided to study the

effect of a rotation of the three kinds of manures: barn-yard manure, bone and muriate of potash and Canada wood ashes, which had been applied for several years previous in succession and upon the same portion of the fields. The area was divided into three plats, Plat 1 (3.97 acres), Plat 2 (2.59 acres) and Plat 3 (3 acres). The system of manuring adopted was as follows: —

Plat 1, wood ashes, 1 ton per acre.

Plat 2, barn-yard manure, 8 tons per acre.

Plat 3, fine-ground bone 600 pounds, and muriate of potash 200 pounds, per acre.

The barn-yard manure was applied broadcast late in autumn, the others early in the spring.

1895. — The above arrangement of plats was continued during that season, and fertilizers were applied in the same proportion to the same plats.

Summary of Yield of Hay (Tons).

	Rate per Acre (Tons).		
	First Cut.	Second Cut, "Rowen."	Total.
1893.			
Plat 1, wood ashes, 1 ton per acre,	2.28	.77	3.05
Plat 2, barn-yard manure, 8 tons per acre,	2.62	.86	3.48
Plat 3, 600 pounds ground bone and 200 pounds muriate of potash per acre,	1.94	.64	2.58
1894.			
Plat 1, wood ashes, 1 ton per acre,	2.50	.37	2.87
Plat 2, barn-yard manure, 8 tons per acre,	2.86	.51	3.37
Plat 3, 600 pounds ground bone and 200 pounds muriate of potash per acre,	2.54	.18	2.72
1895.			
Plat 1, 600 pounds ground bone and 200 pounds muriate of potash per acre,	2.18	1.60	3.14
Plat 2, wood ashes, 1 ton per acre,	2.17	1.44	3.12
Plat 3, barn-yard manure, 8 tons per acre,	3.02	1.04	3.13

The season of 1894 was marked by a severe drought, beginning with the month of July and extending into the fall, which affected the yield of the crop (second cut) to a serious extent. The season of 1895 was a fair one for farm work in our section of the country.

Part II.

REPORT ON THE WORK IN THE CHEMICAL LABORATORY.

CHARLES A. GOESSMANN.

1. On Official Inspection of Commercial Fertilizers in 1895.

During the past year fifty-five manufacturers and dealers in commercial fertilizers and agricultural chemicals have applied for and secured licenses for the sale of their goods in the State; twenty-seven of them being residents of Massachusetts, and the remainder belonging to Vermont, Rhode Island, Connecticut, New York, New Jersey, Maryland, Pennsylvania, Illinois, Ohio and Canada.

The number of different brands collected in the general market amounted to two hundred and ninety. The sampling and collecting of the material for analysis were in charge of Mr. H. D. Haskins, an efficient assistant in the chemical laboratory of the division of chemistry of the station, who for several years past has attended to that part of the inspection in a very satisfactory manner. Two hundred and seventy samples of the various brands collected by him were carefully analyzed, and the results obtained in that direction have been published and distributed in five special bulletins, *i. e.*, No. 57 old series and Nos. 30, 31, 32 and 34 of the Hatch station series.

The results of the inspection have been on the whole quite satisfactory, as far as the compliance of the dealers with the provision of our State laws for the regulation of the trade in commercial fertilizers is concerned. The variations here and there noticed between the guaranteed composition of the dealer and the results of our analyses could be traced with

but few exceptions to imperfect mixing of the several ingredients of the fertilizer, and did not, as a rule, materially affect the commercial value of the article. In this connection attention should be called to the fact that the lowest amount stated in the guarantee is only legally binding. As our State law makes allowance for these circumstances, the results of our examinations have been published without further comment. When deemed best for the interest of all parties concerned, the results have been sent by letter to the manufacturers of the goods, for their guidance and consideration. To convey a more direct idea of the actual value of this feature in the trade of commercial fertilizers of 1895, the following detailed statement is here inserted : —

(*a*) Where three essential elements of plant food were guaranteed : —

Number with three elements equal to or above the highest guarantee,	5
Number with two elements above the highest guarantee,	11
Number with one element above the highest guarantee,	49
Number with three elements between the lowest and highest guarantees,	45
Number with two elements between the lowest and highest guarantees,	54
Number with one element between the lowest and highest guarantees,	27
Number with two elements below the lowest guarantee,	6
Number with one element below the lowest guarantee,	30

(*b*) Where two essential elements of plant food were guaranteed : —

Number with two elements above the highest guarantee,	1
Number with one element above the highest guarantee,	11
Number with two elements between the lowest and highest guarantees,	17
Number with one element between the lowest and highest guarantees,	7
Number with one element below the lowest guarantee,	10

(*c*) Where one essential element of plant food was guaranteed : —

Number above the highest guarantee,	4
Number between the lowest and highest guarantees,	21
Number below the lowest guarantee,	6

The consumption of commercial fertilizers is steadily increasing, a circumstance apparently not less due to a more general recognition of their good services, if judiciously selected and applied, than to gradual improvements in regard to their mechanical condition as well as their general chemical character. A noticeable change regarding the chemical composition of many brands of so-called complete or formula fertilizers of to-day, as compared with those offered for similar purposes at an earlier period in the history of the trade in commercial fertilizers, consists in a more general and more liberal use of potash compounds as a prominent constituent. This change has been slow but decided, and may in a large degree be ascribed to the daily increasing evidence, resting on actual observations in the field and garden, that the farm lands of Massachusetts are quite frequently especially deficient in potash compounds, and consequently need in many instances a more liberal supply of available potash from outside sources to give satisfactory returns. Whenever the cultivation of garden vegetables, fruits and forage crops constitutes the principal products of the land, this recent change in the mode of manuring deserves in particular a serious trial; for the crops raised consume exceptionally large quantities of potash, as compared with grain crops. In view of these facts, it will be conceded that a system of manuring farm and garden, which tends to meet more satisfactory recognized conditions of large areas of land as well as the special wants of important growing branches of agricultural industries, is a movement in the right direction. A judicious management of the trade in commercial fertilizers implies a due recognition of well-established experimental results regarding the requirements of a remunerative production of farm and garden crops.

List of Manufacturers and Dealers who have secured Certificates for the Sale of Commercial Fertilizers in This State during the Past Year (May 1, 1895, to May 1, 1896), and the Brands licensed by Each.

Armour & Co., Chicago, Ill.: —
Bone Meal.
Bone and Blood.
All Soluble.
Bone, Blood and Potash.

H. J. Baker & Bro., New York, N. Y.: —
Standard Unexcelled Fertilizer.
Strawberry Manure.
Complete Onion Manure.
Complete Potato Manure.
Complete Tobacco Manure.
Complete Grass and Lawn Manure.
Complete Corn Manure.
A A Ammoniated Superphosphate.
Strictly Pure Ground Bone.
Vegetable and Vine Fertilizer.

C. A. Bartlett, Worcester, Mass.: —
Complete Animal Fertilizer.
Pure Ground Bone.

Bowker Fertilizer Company, Boston, Mass.: —
Stockbridge Special Manures.
Bowker's Hill and Drill Phosphate.
Bowker's Farm and Garden Phosphate.
Bowker's Lawn and Garden Dressing.
Bowker's Fish and Potash.
Bowker's Potato and Vegetable Manure.
Bowker's Market-garden Manure.
Bowker's Sure Crop Bone Phosphate.
Bowker's Gloucester Fish and Potash.
Bowker's Dry Ground Fish.
Bowker's Fresh Ground Bone.
Nitrate of Soda.
Dried Blood.
Dissolved Bone-black.
Muriate of Potash.
Sulphate of Potash.
Sulphate of Ammonia.

Bradley Fertilizer Company, Boston, Mass.: —
- Bradley's X L Superphosphate.
- Bradley's Potato Manure.
- Bradley's B D Sea-fowl Guano.
- Bradley's Complete Manures.
- Bradley's Fish and Potash.
- Bradley's High-grade Tobacco Manure.
- Bradley's English Lawn Dressing.
- Farmers' New-method Fertilizer.
- Breck's Lawn and Garden Dressing.
- Eclipse Phosphate.
- Dry Ground Fish.
- High-grade Sulphate of Potash.
- Low-grade Sulphate of Potash.
- Muriate of Potash.
- Nitrate of Soda.
- Sulphate of Ammonia.
- Dissolved Bone-black.
- Fine-ground Bone.

Wm. J. Brightman & Co., Tiverton, R. I.: —
- High-grade Potato and Root Manure.
- Brightman's Phosphate.
- Brightman's Fish and Potash.

Bryant, Brett & Simpson, New Bedford, Mass.: —
- Ground Bone.

B. L. Bragg & Co., Springfield, Mass.: —
- Hampden Lawn Dressing.

Dan. T. Church, Providence, R. I.: —
- Church's B Special Fertilizer.
- Church's D Fish and Potash.
- Church's C Standard.

Clark's Cove Fertilizer Company, Boston, Mass.: —
- Bay State Fertilizer.
- Bay State Potato Manure.
- Great Planet Manure.
- Fish and Potash.
- King Philip Guano.
- White Oak Pure Ground Bone.

Clark's Cove Fertilizer Company, Boston, Mass. — *Concluded.*
- Bay State Fertilizer, G G Brand.
- Potato and Tobacco Fertilizer.
- Tobacco Fertilizer.
- Blood, Bone and Meat.
- Dissolved Bone-black.
- Double Manure Salts.
- Sulphate of Potash.
- Muriate of Potash.
- Nitrate of Soda.

Cleveland Dryer Company, Boston, Mass.: —
- Cleveland Superphosphate.
- Potato Phosphate.
- Corn and Grain Phosphate.
- Fertilizer.
- High-grade Complete Manure.

E. Frank Coe Company, New York, N. Y.: —
- Gold Brand Excelsior Guano.
- High-grade Ammoniated Bone Superphosphate.
- Special Potato Fertilizer.
- Fish and Potash.
- High-grade Potato Fertilizer.

Crocker Fertilizer and Chemical Company, Buffalo, N. Y.: —
- Special Potato Fertilizer.
- Ammoniated Bone Superphosphate.
- Ammoniated Wheat and Corn Phosphate.
- New Rival Ammoniated Superphosphate.
- Potato Hop and Tobacco Phosphate.
- Ground Bone Meal.
- Practical Ammoniated Superphosphate.
- Pure Ground Bone.
- Vegetable Bone Superphosphate.

Cumberland Bone Phosphate Company, Boston, Mass.: —
- Superphosphate.
- Potato Fertilizer.
- Fertilizer.
- Concentrated Phosphate.
- Fine-ground Bone.

L. B. Darling Fertilizer Company, Pawtucket, R. I.: —
Animal Fertilizer.
Extra Bone Phosphate.
Potato and Root Fertilizer.
Lawn and Garden Manure.
Tobacco Grower.
Pure Fine Bone.
Pure Dissolved Bone.
High-grade Sulphate of Potash.

John C. Dow & Co., Boston, Mass.: —
Dow's Ground Bone Fertilizer.
Dow's Nitrogenous Superphosphate.
Dow's Pure Ground Bone.

Eastern Farm Supply Association, Montclair, N. J.: —
Carteret Farm Manure.
Carteret Potato Manure.
Carteret Corn and Grain Manure.
Carteret Market-garden Manure.

Forest City Wood Ash Company, Boston, Mass.: —
Unleached Hard-wood Ashes.
Odorless Mineral Guano.

Wm. E. Fyfe & Co., Clinton, Mass.: —
Canada Ashes.

Great Eastern Fertilizer Company, Rutland, Vt.: —
Great Eastern Soluble Bone and Potash.
Great Eastern Grain and Grass.
Great Eastern Oats, Buckwheat and Seeding-down.
Great Eastern Vegetable Vine and Tobacco.

Edmund Hersey, Hingham, Mass.: —
Ground Bone.

John G. Jefferds, Worcester, Mass.: —
Animal Fertilizer.
Potato Fertilizer.
Ground Bone.

A. Lee & Co., Lawrence, Mass.: —
Lawrence Fertilizer.

Lowe Bros. & Co., Fitchburg, Mass. : —
Tankage.

Lowell Rendering Company, Chelmsford, Mass. : —
Lowell Bone Fertilizer.

The Mapes Formula and Peruvian Guano Company, New York, N. Y. : —
Mapes' Bone Manures.
Mapes' Superphosphates.
Mapes' Special Crop Manures.
Mapes' Peruvian Guano.
Mapes' Economical Manure.
Sulphate of Potash.
Double Manure Salts.
Nitrate of Soda.

Mason, Chapin & Co., Providence, R. I. : —
Chemical Compound Corn Fertilizer.
Chemical Compound Lawn Fertilizer.
Chemical Compound Vegetable Fertilizer.
Chemical Compound Tobacco Fertilizer.
Lawn and Grass Fertilizer.

McQuade Bros., Worcester, Mass. : —
Pure Ground Bone.

Monroe, Lalor & Co., Oswego, N. Y. : —
Canada Unleached Hard-wood Ashes.

Robert L. Merwin & Co., New York, N. Y. : —
Albert's Highly Concentrated Horticultural Manure.

National Fertilizer Company, Bridgeport, Conn. : —
Ammoniated Bone Phosphate.
Chittenden's Complete Fertilizer.
Fish and Potash.
Ground Bone.

New England Dressed Meat and Wool Company, Boston, Mass. : —
Sheep Fertilizer.

Niagara Fertilizer Company, Buffalo, N. Y. : —
Niagara Triumph.
Niagara Grain and Grass Grower.
Niagara Wheat and Corn Producer.
Niagara Potato, Tobacco and Hop Fertilizer.

Pacific Guano Company, Boston, Mass.: —
Soluble Pacific Guano.
Special Potato Fertilizer.
Special for Potatoes and Tobacco.
High-grade General Fertilizer.
Fish and Potash.
Muriate of Potash.
Dissolved Bone-black.
Nitrate of Soda.
Sulphate of Potash.

John J. Peters & Co., Long Island City, N. Y.: —
Sheep Fertilizer.

Parmenter & Polsey Fertilizer Company, Peabody, Mass.: —
Plymouth Rock Brand.
Special Potato Fertilizer.
Star Brand Superphosphate.
Ground Bone.
Muriate of Potash.
Nitrate of Soda.

Prentiss Brooks & Co., Holyoke, Mass.: —
Complete Manures.
Phosphate.
Nitrate of Soda.
Tankage.
Dissolved Bone-black.
Muriate of Potash.
Sulphate of Potash.
Fish and Potash.
Fish.

Quinnipiac Company, Boston, Mass.: —
Phosphate.
Potato Manure.
Onion Manure.
Havana Tobacco Fertilizer.
Corn Fertilizer.
Market-garden Manure.
Potato and Tobacco Manure.
Fish and Potash, "Crossed Fishes."
Fish and Potash, "Plain Brand."
Grass Fertilizer.

Quinnipiac Company, Boston, Mass. — *Concluded.*
Pure Bone Meal.
Dry Ground Fish.
Strawberry Manure.
Ammoniated Dissolved Bones.
Nitrate of Soda.
Sulphate of Potash.
Muriate of Potash.
Double Manure Salts.

Read Fertilizer Company, New York, N. Y.: —
Read's Standard.
High-grade Farmers' Friend.
Fish and Potash.
Vegetable and Vine.

N. Roy & Son, South Attleborough, Mass.: —
Animal Fertilizer.

The Rogers & Hubbard Company, Middletown, Conn.: —
Pure Ground Raw Knuckle Bone Meal.
Strictly Pure Fine Bone.
Fertilizer for Oats and Top-dressing.
Soluble Potato Manure.
Fairchild's Formula for Corn and General Crops.
Soluble Tobacco Manure.
Grass and Grain Fertilizer.

Russia Cement Company, Gloucester, Mass.: —
Essex Complete Manure for Potatoes and Roots.
Essex Complete Manure for Corn and Grain.
Essex Perfected Lawn Dressing.
Essex Special Vegetable Manure.
Essex High-grade Fish and Potash.

Lucien Sanderson, New Haven, Conn.: —
Formula "A."
Bone, Meat and Blood.
Dissolved Bone-black.
Sulphate of Potash.
Muriate of Potash.
Nitrate of Soda.

Edward H. Smith, Northborough, Mass.: —
Ground Bone.

Springfield Provision Company, Brightwood, Mass. : —
Blood, Meat and Bone.

Standard Fertilizer Company, Boston, Mass. : —
Complete Manure.
Potato and Tobacco Manure.
Fertilizer.
Guano.
Fish and Potash.
Fine-ground Bone.
Muriate of Potash.
Dissolved Bone-black.

T. L. Stetson, Randolph, Mass. : —
Pure Ground Bone.

F. C. Sturtevant, Hartford, Conn. : —
Ground Tobacco Stems.

Charles Stevens, Napanae, Ontario, Can. : —
Unleached Hard-wood Ashes.

Henry F. Tucker, Boston, Mass. : —
Tucker's Original Bay State Bone Superphosphate.
Tucker's Imperial Bone Superphosphate.
Tucker's Special Potato Fertilizer.

Thompson & Edwards Fertilizer Company, Chicago, Ill. : —
Pure Fine-ground Bone.

Walker, Stratman & Co., Pittsburg, Pa. : —
Potato Special.
Smoky City.
Big Bonanza.
Four Fold.

M. E. Wheeler & Co., Rutland, Vt. : —
High-grade Fruit Fertilizer.
Grass and Oats Fertilizer.
Electrical Dissolved Bone.
Potato Manure.
High-grade Corn Fertilizer.

Leander Wilcox, Mystic, Conn. : —
- Potato, Onion and Tobacco Manure.
- Ammoniated Bone Phosphate.
- Fish and Potash.
- Dry Ground Fish.

Williams & Clark Fertilizer Company, Boston, Mass. : —
- Americus Ammoniated Bone Superphosphate.
- Potato Phosphate.
- Grass Manure.
- Pure Bone Meal.
- High-grade Special.
- Corn Phosphate.
- Fine Wrapper Tobacco Fertilizer.
- Universal Ammoniated Dissolved Bone.
- Fish and Potash.
- Dry Ground Fish.
- Potato and Tobacco Manure.
- Royal Bone Phosphate.
- Onion Manure.
- Dissolved Bone-black.
- Nitrate of Soda.
- Double Manure Salts.
- Sulphate of Potash.
- Muriate of Potash.

2. General Work in the Laboratory of the Division of Chemistry.

The work in the chemical laboratory of the united stations has been divided by a recent vote of the board of trustees between the newly created division of "Foods and Feeding" and the "Division of Chemistry." The separate operation of the two divisions dates from July 1, 1895. The analyses of feeds stuffs, dairy products and well waters made before that date are incorporated in the annual report of Dr. J. B. Lindsey, who by vote of the trustees has been placed in charge of the new division of foods and feeding, which includes in its scope the examination of these substances.

Aside from the supervision of the inspection of commercial fertilizers, the results of which are discussed in a few preceding pages, my attention has been divided between the direction of a series of experiments in the field and vegetation house, introduced some years ago for the purpose of studying the economy of various systems of manuring and raising field and garden crops, and an extensive correspondence with farmers and others, asking for information regarding a variety of subjects of interest to them. The description of the former constitutes the first part of this report. The results of the examination of many manurial substances sent on for that purpose in connection with the latter, whenever of general interest, have been published during the past year in the bulletins of the station. They are also recorded in connection with the tabular compilation of analyses of manurial substances which accompanies this report.

The constantly increasing variety of waste products of many branches of industry within our State and elsewhere which have proved of manurial value, has received for years a serious attention. Both producers and consumers have been materially benefited by this work, which aims to make known the particular fitness of each for manurial purposes, and thereby furnishes a basis for the determination of its commercial value. As a change in the current modes of manufacture of the parent industry is at any time liable to

seriously affect the character and chemical composition of the waste or by-products, it becomes necessary to repeat from time to time analyses of many of these products. These analyses are made without any charge for the work, on the condition that the results are public property, if deemed of interest for publication.

As a brief enumeration of the more prominent substances sent on for our investigation during the year 1895 can best convey a correct idea concerning the extent and importance of the labor involved, the following statement is presented: the whole number of analyses made in the stated connection amounts for the year 1895 to one hundred and eighty-six; of these, from eighty to ninety consisted of ashes, including wood ashes, coal ashes, lime-kiln ashes, cotton-hull ashes, swill ashes, soots, etc.; from twenty to thirty were agricultural chemicals, comprising potash salts, Chili saltpetre, sulphate of ammonium, gypsum, kainites, dissolved bone-black, phosphatic slag, etc.; twenty-eight were animal refuse materials, as fish waste, tankage, blood, animal meal, meat scraps, blood and bone, bones, wool waste, sheep fertilizer, etc.; and from twenty to thirty consisted of vegetable refuse materials, as cotton-factory waste, cotton-seed meal, tobacco stems, madder, peats, vegetable compost, etc.

Of a special interest is the recent introduction of the products prepared from the kitchen refuse of our large cities. Sanitary considerations are indirectly the cause of the appearance of these products, which promise to become of considerable prominence in the future.

One mode disposes of the refuse by cremation. The product resulting is called cremation ashes, and contains a liberal amount of phosphate of lime and more or less potash. The nitrogen and organic matter are lost in the process of cremation. Grinding and proper mixing of the products cannot fail to furnish a valuable material for manurial purposes. The tabular statement below gives the results of analyses of swill or cremation ashes, mostly if not entirely from Lowell, Mass.

Another mode proposes to save the nitrogen and organic matter by a so-called reduction process. The parties in-

terested in the matter propose to reduce the garbage with sulphuric acid, remove the fat, add to the refuse natural phosphates to combine with the excess of sulphuric acid, and add potash compounds if needed. This interesting process is apparently still in the experimental stage. A sample of the product sent here for examination gives the results found below. Modern views regarding the requirements of sanitary condition in our centres of population cannot fail to recognize the efficiency of both processes to dispose of objectionable material. The economical advantages derived from these modes of operation experience alone can determine. The product of either mode has its special claim for consideration. The agricultural interests of the country cannot fail to benefit by a successful development of either mode of operation.

Analyses of Ashes from a Crematory Furnace, Lowell, Mass.

	1.	2.	3.	4.	5.	6.	7.
Moisture at 100° C.,	0.51	0.07	0.04	0.11	2.43	19.46	12.48
Potassium oxide,	1.73	8.83	7.03	1.25	1.59	1.78	3.35
Phosphoric acid,	16.61	17.18	26.09	32.26	25.89	5.22	6.50
Calcium oxide,	24.79	28.18	33.74	47.60	–*	–*	–*
Ferric and aluminic oxides,	3.56	7.63	6.25	1.06	–*	–*	–*
Magnesium oxide,	1.87	–*	–*	–*	–*	–*	–*
Insoluble matter before calcination,	39.60	18.49	14.40	15.13	–*	–*	–*
Insoluble matter after calcination,	29.72	16.53	11.41	13.20	17.93	30.81	31.54

	8.	9.	10.	11.	12.	13.	14.
Moisture at 100° C.,	0.37	7.57	14.24	8.05	1.20	1.19	0.87
Potassium oxide,	4.27	3.96	5.09	4.92	5.71	4.83	4.08
Phosphoric acid,	12.97	13.92	6.86	13.22	10.82	10.21	71.47
Insoluble matter after calcination,	34.91	19.96	37.76	24.52	29.91	24.50	26.73

* Not determined.

Analysis of a Refuse Product obtained from City Garbage, sent on by the American Reduction Company, New York City.

	Per Cent.
Moisture at 100° C.,	8.52
Nitrogen,	1.64
Potassium oxide,	1.20
Sodium oxide,	2.50
Calcium oxide,	3.86
Magnesium oxide,	.55
Ferric and aluminic oxides,	7.64
Total phosphoric acid,	10.62
Available phosphoric acid,	8.08
Insoluble phosphoric acid,	2.54
Sulphuric acid,	8.54
Organic matter,	45.43
Insoluble matter (ash),	12.15

3. Compilation of Analyses made at Amherst, Mass., of Agricultural Chemicals and Refuse Materials used for Fertilizing Purposes.

Prepared by H. D. Haskins.

[As the basis of valuation changes from year to year, no valuation is stated.]

1868 to 1896.

This compilation does not include the analyses made of licensed fertilizers. They are to be found in the reports of the State Inspector of Fertilizers from 1873 to 1896, contained in the reports of the Secretary of the Massachusetts State Board of Agriculture for those years.

C. A. G.

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
I. Chemicals, Refuse, Salts, Ashes, etc.																							
Muriate of potash,	79	1.80	-	-	-	-	58.98	45.94	**51.02**	-	-	-	-	-	-	6.69	-	.55	-	-	-	48.80	.70
Sulphate of potash,	32	2.12	-	-	-	-	51.30	21.36	**38.67**	-	-	-	-	-	-	4.46	-	1.50	-	45.72	-	-	.75
Sulphate of potash-magnesia,	26	4.85	-	-	-	-	29.48	16.96	**24.82**	-	-	-	-	-	-	6.25	2.57	-	-	44.25	-	2.60	1.41
Carbonate of potash,	1	26.88	-	-	-	-	-	-	**18.48**	-	-	-	-	-	-	-	-	19.52	-	-	-	-	.39
Phosphate of potash,	1	3.76	-	-	-	-	-	-	**32.56**	-	-	**37.50**	-	-	-	-	-	-	-	13.43	-	-	.92
Kainite,	5	3.18	-	-	-	-	16.48	12.51	**13.56**	-	-	-	-	-	-	18.97	1.15	9.80	-	20.25	-	33.25	2.13
Carnallite,	1	-	-	-	-	-	-	-	**13.68**	-	-	-	-	-	-	7.66	-	13.19	-	.56	-	41.56	-
Krugite,	1	4.82	-	-	-	-	-	-	**8.42**	-	-	-	-	-	-	5.27	12.45	8.79	-	31.94	-	6.63	14.96
Sulphate of magnesia (Kieserite),	9	22.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.82	17.30	-	36.10	-	-	5.73
Nitrate of potash,	4	1.30	-	14.58	11.60	**12.71**	45.62	44.76	**45.27**	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate of soda,	36	1.42	-	16.22	14.28	**15.02**	-	-	-	-	-	-	-	-	-	35.50	-	-	-	-	-	.50	.50
Sulphate of ammonia,	28	1.06	-	21.68	19.59	**22.03**	-	-	-	-	-	-	-	-	-	-	-	-	-	60.00	-	-	-
Phosphate of ammonia,	1	6.05	-	-	-	**10.37**	-	-	-	-	-	**43.86**	-	-	-	-	-	-	-	12.46	-	-	.82
Sulphate of soda,	1	1.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	59.43	-	-	-
Saltpetre waste,	12	2.54	-	3.30	.52	**2.22**	30.94	1.55	**13.66**	-	-	-	-	-	-	37.04	.75	.19	-	1.85	-	46.25	-

Nitre salt-cake,	2	6.03	-	-	-	2.29	-	-	.87	-	-	-	-	-	-	29.56	-	-	-	47.77	-	-	3.92
Wood ashes,	476	10.64	-	-	-	-	10.80	1.20	5.37	5.58	.05	1.52	-	-	-	-	33.58	3.31	.96	-	-	-	14.22
Cotton-seed-hull ashes,	49	8.21	-	-	-	-	42.12	9.91	22.77	13.67	2.89	8.15	-	-	-	-	9.30	10.47	1.76	-	-	-	13.44
Ashes of spent tan-bark,	5	4.84	-	-	-	-	2.87	.60	1.81	2.77	.13	1.36	-	-	-	-	31.11	3.39	1.78	-	-	-	25.21
Corn-cob ashes,	1	1.20	-	-	-	-	-	-	7.08	-	-	2.37	-	-	-	-	11.70	-	1.28	-	-	-	52.09
Railroad-tie ashes,	1	4.70	-	-	-	-	-	-	.92	-	-	.56	-	-	-	-	2.51	-	-	-	-	-	80.20
Peat ashes,	1	4.67	-	-	-	-	-	-	.46	-	-	.11	-	-	-	-	2.28	1.63	6.13	-	-	-	45.17
Logwood ashes,	1	1.50	-	-	-	-	-	-	.08	-	-	2.30	-	-	-	-	3.90	-	-	-	-	-	9.70
Hard-pine wood ashes,	1	.75	-	-	-	-	-	-	10.16	-	-	2.24	-	-	-	-	24.95	-	-	-	-	-	29.90
Mill ashes,	1	.53	-	-	-	-	-	-	1.60	-	-	.46	-	-	-	-	34.93	1.35	-	-	-	-	36.36
Ashes from cremation of swill,	14	4.89	-	-	-	-	8.83	1.25	4.17	32.36	7.47	14.66	-	-	-	-	33.58	1.87	4.65	-	-	-	19.73
Ashes from blue works,	1	12.14	63.78	-	-	-	-	-	9.02	-	-	-	-	-	-	-	-	-	-	-	-	-	12.30
Sea-weed ashes,	1	1.47	-	-	-	-	-	-	.92	-	-	.30	-	-	-	8.76	6.06	4.37	-	2.98	-	6.60	63.65
Gypse,	1	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50.87	-	-	-	-	-	2.87
Nova Scotia plaster (gypsum),	15	8.63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32.85	.75	-	45.12	-	-	3.47
Onondaga plaster (New York gypsum),	4	13.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.00	4.66	-	32.50	8.20	-	9.83
Lime,	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	93.63	-	-	-	-	-	1.33
Waste lime,	1	.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	74.12	-	-	-	-	-	.38
Gas-house lime,	3	22.28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43.66	8.30	-	20.73	-	-	6.05
Lime waste from sugar factory,	1	36.30	-	-	-	-	-	-	.22	-	-	2.25	-	-	-	-	27.51	-	-	-	-	-	.32
Lime-kiln ashes,	17	14.48	-	-	-	-	2.78	.02	1.28	3.16	.36	1.09	-	-	-	-	42.57	2.60	-	-	17.75	-	7.69
Bituminous coal ashes,	1	7.18	-	-	-	-	-	-	.60	-	-	.43	-	-	-	-	-	-	-	-	-	-	68.50

	Analyses.	Moisture.	Ash.	Nitrogen. Maximum.	Nitrogen. Minimum.	Nitrogen. Average.	Potash. Maximum.	Potash. Minimum.	Potash. Average.	Total Phosphoric Acid. Maximum.	Total Phosphoric Acid. Minimum.	Total Phosphoric Acid. Average.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
I. Chemicals, Refuse, Salts, Ashes, etc. —Concluded.																							
Marls (Massachusetts), ...	7	13.70	–	–	–	–	–	–	.24	2.72	.06	1.05	–	–	–	–	40.50	.64	.69	–	28.57	–	3.44
Marls (Virginia), ...	2	15.98	–	–	–	–	.61	.37	.49	.09	.08	.09	–	–	–	–	7.25	.21	–	.66	7.25	–	64.23
Green sand marl (Virginia), . . .	1	1.25	–	–	–	–	–	–	1.14	–	–	9.37	–	–	–	–	25.78	–	5.13	–	–	–	41.32
Olive earth (Virginia), ...	1	1.97	–	–	–	–	–	–	.24	–	–	13.73	–	–	–	–	19.16	–	6.00	–	–	–	50.55
Ammoniated marl, ...	1	3.31	–	–	–	1.61	–	–	–	–	–	10.39	–	.41	9.98	–	–	–	–	–	–	–	–
Marl (North Carolina), ...	1	1.50	–	–	–	–	–	–	.04	–	–	.56	–	–	–	–	21.95	.61	–	–	–	–	50.18
Clay (so called), ...	1	.70	–	–	–	–	–	–	–	–	–	–	–	–	–	–	54.35	1.04	2.80	–	37.32	–	2.57
II. Guanos, Phosphates, etc.																							
Peruvian guano, ...	26	14.81	37.61	13.50	4.44	7.85	4.08	1.14	2.61	20.60	5.96	15.26	4.57	3.79	6.90	–	–	–	–	–	–	–	6.60
Bat guano from Texas, ...	9	40.09	18.24	10.51	2.58	6.47	–	–	1.31	6.53	1.00	3.76	–	–	–	–	–	–	–	–	–	–	2.00
Bat guano from Florida, ...	2	15.66	–	–	–	9.74	–	–	1.77	3.44	3.26	3.35	–	–	–	–	–	–	–	–	–	–	19.33
Rat guano from Florida, ...	1	10.32	–	–	–	3.32	–	–	6.85	–	–	2.30	–	–	–	–	–	–	–	–	–	–	1.15
Cuban guano, ...	5	24.27	–	2.74	.63	1.67	–	–	–	16.16	11.54	13.35	–	–	–	–	–	–	–	–	–	–	3.17
Caribbean guano (orchilla), . . .	12	7.31	–	–	–	–	–	–	–	35.43	18.11	26.77	–	–	–	–	39.95	3.29	–	2.68	–	–	1.27
Mona Island guano, ...	1	13.32	–	–	–	.76	–	–	–	–	–	21.88	–	7.55	14.33	–	37.49	–	–	–	–	–	2.45

South Carolina rock phosphate,	6	1.45	-	-	-	-	-	-	-	30.51	24.70	27.47	.27	.07	27.13	-	41.87	3.03	4.80	-	-	-	9.04
South Carolina floats,	1	.83	-	-	-	-	-	-	-	-	-	23.39	-	2.33	21.06	-	-	-	-	-	-	-	20.16
Florida rock phosphate,	29	2.09	-	-	-	-	-	-	-	38.97	6.95	26.15	-	-	-	-	30.40	-	7.56	-	-	-	27.29
Soft Florida phosphate,	3	4.87	-	-	-	-	-	-	-	19.94	17.71	18.73	-	-	-	-	23.72	-	6.82	-	-	-	20.92
Navassa phosphate,	2	7.60	-	-	-	-	-	-	-	34.45	34.09	34.27	-	-	-	-	37.45	-	10.27	-	-	-	2.70
Brockville phosphate,	1	2.50	-	-	-	-	-	-	-	-	-	35.21	-	-	-	-	-	-	-	-	-	-	6.46
Phosphatic slag,	4	1.45	-	-	-	-	-	-	-	30.51	18.91	23.49	-	3.06	21.65	-	48.66	3.42	10.12	-	-	-	9.40
Odorless phosphate,	6	2.99	-	-	-	-	.52	.04	.38	21.74	18.40	19.54	-	.52	19.82	-	51.42	-	-	-	2.51	-	9.14
Dissolved bone-black,	6	10.31	47.50	-	-	-	-	-	-	17.54	14.99	16.00	14.48	1.15	.37	-	-	-	-	-	-	-	3.99
Bone-black,	5	4.60	-	-	-	-	-	-	-	30.54	16.56	28.28	-	-	-	-	-	-	-	-	-	-	3.64
Double superphosphate,	1	5.74	-	-	-	-	-	-	-	-	-	47.80	38.38	9.04	.38	-	16.00	-	-	1.19	-	-	.60
South American bone-ash,	1	7.00	-	-	-	-	-	-	-	-	-	35.89	-	-	-	-	44.89	-	-	-	-	-	4.50
Acid phosphate,	1	14.23	69.95	-	-	-	-	-	-	-	-	14.64	10.34	2.42	1.88	-	-	-	-	-	-	-	10.81
III. Refuse Substances.																							
Dried blood,	17	11.97	6.37	13.55	8.10	10.48	-	-	-	6.23	1.30	2.00	-	-	-	-	-	-	-	-	-	-	-
Ammonite,	1	5.88	-	-	-	11.33	-	-	-	-	-	3.43	-	-	-	-	-	-	-	-	-	-	1.38
Oleomargarine refuse,	1	8.54	14.42	-	-	12.12	-	-	-	-	-	.88	-	-	-	-	-	-	-	-	-	-	.96
Felt refuse,	1	29.24	33.53	-	-	5.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sponge refuse,	1	7.25	-	-	-	2.43	-	-	-	-	-	3.19	-	-	-	-	3.94	1.27	-	-	-	-	39.05
Blood and bone,	2	8.36	-	6.80	6.68	6.74	-	-	-	11 39	10.62	11.01	-	2.82	7.80	-	-	-	-	-	-	-	-
Horn shavings,	1	4.83	-	-	-	15.31	-	-	-	-	-	.42	-	-	-	-	-	-	-	-	-	-	-

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
III. Refuse Substances — Continued.																							
Ivory dust,	1	11.50	52.63	-	-	6.64	-	-	-	-	-	24.56	.97	17.97	5.62	-	-	-	-	-	-	-	-
Horn and hoof waste,	3	10.17	7.63	15.49	11.84	13.25	-	-	-	2.30	1.36	1.83	-	-	-	-	-	-	-	-	-	-	.24
Raw wool,	1	6.95	7.54	-	-	12.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.63
Wool waste,	11	11.77	24.10	10.20	.96	4.56	3.50	.06	1.68	.67	.05	.31	-	-	-	-	.11	.06	.80	-	-	-	8.20
Wool washings (water),	1	-	-	-	-	-	-	-	3.92	-	-	-	-	-	-	.49	.28	-	-	-	-	-	-
Wool washings (acid),	1	-	-	-	-	-	-	-	4.20	-	-	-	-	-	-	.40	.61	.20	-	-	-	-	-
Wool washings (alkaline),	1	92.03	3.28	-	-	.09	-	-	1.09	-	-	-	-	-	-	.92	.04	-	-	-	-	-	.22
Morocco factory waste,	1	22.72	-	-	-	1.16	-	-	.36	-	-	2.56	-	-	-	-	19.60	-	-	1.24	-	-	24.17
Meat scrap,	2	24.79	-	-	-	6.33	-	-	-	-	-	5.79	-	-	-	-	-	-	-	-	-	-	-
Meat mass,	5	12.09	13.60	11.50	9.69	10.44	-	-	-	3.58	.56	2.07	-	-	-	-	-	-	-	-	-	-	.58
Bone soup,	1	82.92	7.07	-	-	1.14	-	-	-	-	-	1.26	-	-	-	-	-	-	-	-	-	-	-
Dried soup from meat and bone,	1	14.80	8.40	-	-	9.97	-	-	-	-	-	.53	-	-	-	-	-	-	-	-	-	-	.64
Dried soup from rendering cattle feet,	1	10.80	7.50	-	-	14.47	-	-	-	-	-	.46	-	-	-	-	-	-	-	-	-	-	.26
Dried soup from horse rendering,	1	92.14	-	-	-	1.12	-	-	-	-	-	.14	-	-	-	-	-	-	-	-	-	-	-
Soap-grease refuse,	2	29.25	51.39	4.20	2.21	3.21	-	-	-	15.37	11.04	13.21	-	-	-	-	-	-	-	-	-	-	1.29
Bones,	164	6.87	53.03	4.70	1.57	3.91	-	-	-	32.52	15.16	22.37	.38	8.22	13.74	-	-	-	-	-	-	-	1.08

Meat and bone,	2	5.26	-	-	-	4.57	-	-	-	-	-	20.21	.26	7.03	13.05	-	-	-	-	-	-	-	1.22
Tankage,	11	9.57	-	9.16	4.29	6.83	-	-	-	15.86	4.03	11.49	-	4.06	7.46	-	-	-	-	-	-	-	-
Fish with less than twenty per cent. water,	71	12.31	21.50	11.40	5.97	7.56	-	-	-	15.91	5.50	8.48	.55	2.64	5.06	-	-	-	-	-	-	-	2.01
Fish with between twenty and forty per cent. water.	10	30.19	20.59	7.41	4.22	5.97	-	-	-	8.32	4.68	7.09	.74	2.69	3.64	-	-	-	-	-	-	-	1.68
Fish with more than forty per cent water,	10	45.46	15.50	7.60	2.43	4.97	-	-	-	8.56	2.94	5.08	1.17	1.33	2.58	-	-	-	-	-	-	-	1.35
Whale meat, raw,	1	44.50	1.04	-	-	4.86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lobster shells,	1	7.27	-	-	-	4.50	-	-	-	-	-	3.52	-	-	-	-	22.24	1.30	-	-	-	-	.27
Castor-bean pomace,	6	9.68	5.70	5.72	5.22	5.51	3.40	.64	1.57	2.26	1.57	2.18	-	-	-	-	.87	.29	-	-	-	-	1.75
Cotton-seed meal,	33	6.78	5.78	7.70	4.02	6.77	2.38	.48	1.77	3.36	.73	1.65	-	-	-	-	-	-	-	-	-	-	.28
Rotten brewers' grain,	1	78.77	-	-	-	.72	-		.04	-	-	.43		-	-	-	.26	.15	-	-	-	-	.59
Mill sweepings,	1	9.49	-	-	-	3.76	-	-	.66	-	-	1.18	-	-	-	-	-	-	-	-	-	-	5.01
Tobacco leaf,	1	13.05	21.01	-	-	2.75	-	-	7.24	-	-	.43	-	-	-	-	4.17	2.17	.32	-	-	-	4.17
Tobacco stems,	7	10.61	14.07	2.91	.90	2.30	10.60	3.76	7.03	2.09	.44	.62	-	-	-	.34	3.89	1.23	-	-	-	-	.82
Cotton waste, wet,	1	34.69	-	-	-	1.30	-	-	.80	-	-	1.54	-	-	-	-	2.45	1.13	-	-	-	-	41.33
Cotton waste, dry,	4	5.87	60.60	9.33	.96	1.77	1.76	.66	1.42	1.80	.26	.45	-	-	-	-	-	-	-	-	-	-	32.59
Refuse from calico works,	1	4.07	-	-	-	4.28	-	-	-	-	-	11.95	-	-	-	-	-	-	-	-	-	-	-
Cotton dust,	1	34.46	50.93	-	-	.50	-	-	.19	-	-	.21	-	-	-	-	.90	.90	-	-	-	-	47.46
Glucose refuse,	1	8.10	-	-	-	2.62	-	-	.15	-	-	.29	-	-	-	-	.18	.02	-	-	-	-	.07
Waste from lactate factory,	1	34.11	-	-	-	.68	-	-	-	-	-	.67	-	-	-	-	22.59	-	-	-	-	-	6.92
Hop refuse,	1	8.98	-	-	-	.98	-	-	.11	-	-	.20	-	-	-	-	.27	.10	-	-	-	-	.63
Banana skins,	1	13.99	-	-	-	.24	-	-	5.46	-	-	1.80	-	-	-	-	-	-	-	-	-	-	-
Tankage and blood,	1	14.43	-	-	-	5.88	-	-	-	-	-	6.84	5.44	1.08	.32	-	-	-	-	-	-	-	-

	Analyses.	Moisture.	Ash.	Nitrogen. Maximum.	Nitrogen. Minimum.	Nitrogen. Average.	Potash. Maximum.	Potash. Minimum.	Potash. Average.	Total Phosphoric Acid. Maximum.	Total Phosphoric Acid. Minimum.	Total Phosphoric Acid. Average.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
III. Refuse Substances — Concluded.																							
Sumac waste,	1	63.06	6.80	-	-	1.19	-	-	3.25	-	-	-	-	-	-	-	1.14	3.25	-	-	-	-	2.25
Eel-grass,	2	35.39	15.60	.96	.70	.83	1.61	.21	.91	.41	.22	.32	-	-	-	1.63	2.13	.11	-	-	-	-	1.06
Pine-barren grass,	1	8.48	2.40	-	-	.16	-	-	.07	-	-	.18	-	-	-	-	-	-	-	-	-	-	1.67
Pine needles,	1	9.48	3.42	-	-	.46	-	-	.03	-	-	.12	-	-	-	-	-	-	-	-	-	-	1.22
Rockweed, green,	1	68.50	23.70	-	-	.62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rockweed, dry,	1	10.68	35.75	-	-	1.45	-	-	4.89	-	-	2.75	-	-	-	7.90	7.66	.21	-	-	-	-	10.40
Jute waste,	1	13.10	-	-	-	1.50	-	-	.08	-	-	.72	-	-	-	-	-	-	-	-	-	-	-
Hair waste,	1	72.81	-	-	-	1.39	-	-	.32	-	-	.61	-	-	-	-	-	-	-	-	-	-	-
Starch waste from rubber factory,	1	10.01	.23	-	-	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludge from sewage precipitating tanks,	1	88.49	9.50	-	-	.05	-	-	.05	-	-	.10	-	-	-	-	1.58	.39	6.22	-	-	-	.93
Sludge,	1	6.28	-	-	-	.68	-	-	-	-	-	1.36	-	-	-	-	8.66	-	17.68	-	-	-	38.03
Residue from water filter,	1	94.22	-	-	-	.12	-	-	-	-	-	.05	-	-	-	-	-	-	-	-	-	-	-
Blue-green algæ (*Lyngbia majuscula*), dry,	1	16.26	-	-	-	4.25	-	-	.79	-	-	.19	-	-	-	3.53	2.06	1.18	-	-	-	-	5.53
Mussel mud, wet,	1	60.01	27.29	-	-	.21	-	-	6.17	-	-	.10	-	-	-	.70	.93	.14	3.48	-	-	-	-
Mussel mud, dry,	1	2.24	72.02	-	-	.72	-	-	-	-	-	.35	-	-	-	-	23.39	-	8.26	-	-	-	37.60
Madder,	2	11.93	-	-	-	.91	-	-	2.40	-	-	.35	-	-	-	-	3.93	.51	-	-	-	-	4.67

Salt mud,	2	53.37	41.19	.40	.39	.40	.33	.32	.33	-	-	-	-	-	-	.94	.91	.37	4.13	-	-	-	34.88
Fresh-water mud,	1	40.37	-	-	-	1.37	-	-	.22	-	-	.26	-	-	-	-	1.27	.29	1.80	-	-	-	18.26
Muck,	22	59.72	13.75	2.54	.26	.86	-	-	-	.17	.08	.13	-	-	-	-	-	-	-	-	-	-	11.35
Peat, wet,	11	61.36	7.66	1.40	.41	.85	-	-	.18	-	-	.09	-	-	-	-	.55	.72	2.14	-	-	-	2.14
Peat, dry,	2	14.67	17.26	-	-	1.89	-	-	.06	-	-	.03	-	-	-	-	-	-	-	-	-	-	10.14
Turf,	2	19.29	6.36	1.97	1.91	1.94	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soot,	7	4.29	77.10	1.05	.09	.41	1.83	.21	.63	2.10	.19	1.13	-	-	-	-	2.99	1.19	6.38	-	-	-	66.06
IV. Animal Excrement, etc.																							
Barn-yard manure,	76	67.01	-	1.36	.21	.52	1.40	.13	.56	.75	.10	.39	-	-	-	-	.30	.19	-	-	-	-	8.09
Horse manure,	1	11.24	-	-	-	.74	-	-	2.82	-	-	1.46	-	-	-	-	-	-	-	-	-	-	12.60
Sheep manure,	2	50.26	-	-	-	1.15	-	-	.64	-	-	.66	-	-	-	-	-	-	-	-	-	-	12.91
Drainage from a manure heap,	1	93.20	3.66	-	-	.98	-	-	.88	-	-	.24	-	-	-	-	-	-	-	-	-	-	-
Poudrette, dry,	1	5.25	35.45	-	-	3.58	-	-	.49	-	-	5.74	-	-	-	-	-	-	-	-	-	-	4.65
Goose manure,	1	48.92	-	-	-	.21	-	-	.81	-	-	.95	-	-	-	-	-	-	-	-	-	-	-
Hen manure, fresh,	2	52.35	24.75	1.20	.79	.99	.32	.18	.25	1.00	.47	.74	-	-	-	-	1.19	.89	-	1.24	-	-	23.50
Hen-house refuse,	1	3.43	-	-	-	.98	-	-	.60	-	-	1.28	-	-	-	-	-	-	-	-	-	-	-

Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds.

	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
I. Chemicals, Refuse, Salts, Ashes, etc.													
Muriate of potash,	36.	-	-	1020.	-	134.	-	11.	-	-	-	976.	14.
Sulphate of potash (high grade),	42.	-	-	1020.	-	-	-	-	-	866.	-	-	15.
Sulphate of potash-magnesia,	97.	-	-	496.	-	125.	51.	-	-	885.	-	52.	28.
Carbonate of potash,	538.	-	-	370.	-	-	-	390.	-	-	-*	-	8.
Phosphate of potash,	75.	-	-	651.	750.	-	-	-	-	269.	-	-	18.
Kainite,	64.	-	-	271.	-	379.	23.	196.	-	405.	-	665.	43.
Carnallite,	-	-	-	274.	-	153.	-	264.	-	11.	-	831.	-
Krugite,	96.	-	-	168.	-	105.	249.	176.	-	639.	-	133.	299.
Sulphate of magnesia (kieserite),	454.	-	-	-	-	-	56.	346.	-	722.	-	-	115.
Nitrate of potash,	26.	-	254.	905.	-	-	-	-	-	-	-	-	-
Nitrate of soda,	28.	-	300.	-	-	710.	-	-	-	-	-	10.	10.
Sulphate of ammonia,	212.	-	441.	-	-	-	-	-	-	1200.	-	-	-
Phosphate of ammonia,	120.	-	207.	-	877.	-	-	-	-	249.	-	-	16.
Sulphate of soda,	28.	-	-	-	-	-	-	-	-	1189.	-	-	-
Saltpetre waste,	51.	-	44.	273.2	-	740.8	15.	38.	-	37.	-	925.	-

Nitre salt-cake,	121.	-	56.	17.	-	591.	-	-	-	955.	-	-	78.
Wood ashes,	213.	-	-	107.	30.	-	712.	66.	19.	-	-	-	284.
Cotton-seed-hull ashes,	164.	-	-	455.	163.	-	186.	209.	35.	-	-	-	269.
Ashes of spent tan-bark,	97.	-	-	36.	37.	-	622.	68.	36.	-	-	-	504.
Corn-cob ashes,	24.	-	-	142.	47.	-	234.	-	26.	-	-	-	1042.
Railroad-tie ashes,	94.	-	-	18.	11.	-	50.	-	-	-	-	-	1604.
Peat ashes,	93.	-	-	9.	2.	-	46.	33.	123.	-	-	-	903.
Logwood ashes,	30.	-	-	2.	56.	-	78.	-	-	-	-	-	194.
Hard-pine wood ashes,	15.	-	-	203.	45.	-	499.	-	-	-	-	-	598.
Mill ashes,	11.	-	-	32.	9.	-	699.	27.	-	-	-	-	727.
Ashes from cremation of swill,	98.	-	-	93.	293.	-	672.	37.	.93	-	-	-	395.
Ashes from blue works,	243.	1276.	-	180.	-	-	-	-	-	-	-	-	246.
Seaweed ashes,	29.	-	-	18.	6.	175.	121.	87.	-	60.	-	132.	1273.
Gypse,	33.	-	-	-	-	-	1017.	-	-	-	-	-	57.
Nova Scotia plaster (gypsum),	173.	-	-	-	-	-	657.	15.	-	902.	-	-	69.
Onondaga plaster (New York gypsum),	265.	-	-	-	-	-	606.	93.	-	650.	164.	-	187.
Lime (burnt),	-	-	-	-	-	-	1973.	-	-	-	-	-	27.
Waste lime,	16.	-	-	-	-	-	1482.	-	-	-	-	-	8.
Gas-house lime,	446.	-	-	-	-	-	873.	166.	-	415.	-	-	121.
Lime waste from sugar factory,	726.	-	-	4.	45.	-	550.	-	-	-	-	-	6.
Lime-kiln ashes,	290.	-	-	26.	22.	-	851.	52.	-	-	355.	-	154.
Bituminous coal ashes,	144.	-	-	12.	9.	-	-	-	-	-	-	-	1370.

* Not determined.

Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds — Continued.

	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
I. Chemicals, Refuse, Salts, Ashes, etc. — Concluded.													
Marls (Massachusetts),	274.	-	-	5.	21.	-	810.	13.	14.	-	571.	-	69.
Marls (Virginia),	320.	-	-	10.	2.	-	145.	4.	-	13.	145.	-	1285.
Green sand marls (Virginia),	25.	-	-	23.	187.	-	516.	-	103.	-	-	-	826.
Olive earth (Virginia),	39.	-	-	5.	275.	-	383.	-	120.	-	-	-	1011.
Ammoniated marl,	66.	-	32.	-	208.	-	-	-	-	-	-	-	-
Marl (North Carolina),	30.	-	-	1.	11.	-	439.	12.	-	-	-	-	1004.
II. Guanos, Phosphates, etc.													
Peruvian guano,	296.	752.	157.	52.	305.	-	-	-	-	-	-	-	132.
Bat guano from Texas,	802.	365.	129.	26.	75.	-	-	-	-	-	-	-	40.
Bat guano from Florida,	313.	-	195.	25.	67.	-	-	-	-	-	-	-	387.
Rat guano from Florida,	206.	-	66.	137.	46.	-	-	-	-	-	-	-	23.
Cuban guano,	485.	-	33.	-	267.	-	-	-	-	-	-	-	63.
Caribbean guano (orchilla),	146.	-	-	-	535.	-	799.	66.	-	54.	-	-	25.
Mona Island guano,	266.	-	15.	-	438.	-	750.	-	-	-	-	-	49.

South Carolina rock phosphate,	29.	-	-	-	549.	-	837.	61.	96.	-	-	-	131.
South Carolina floats,	17.	-	-	-	468.	-	-	-	-	-	-	-	403.
Florida rock phosphate,	42.	-	-	-	523.	-	608.	-	151.	-	-	-	556.
Soft Florida phosphate,	97.	-	-	-	375.	-	274.	-	136.	-	-	-	418.
Navassa phosphate,	152.	-	-	-	685.	-	749.	-	205.	-	-	-	54.
Brockville phosphate,	50.	-	-	-	704.	-	-	-	-	-	-	-	129.
Phosphatic slag,	29.	-	-	-	470.	-	973.	68.	202.	-	-	-	188.
Odorless phosphate,	60.	-	-	8.	391.	-	1028.	-	-	-	50.	-	183.
Dissolved bone-black,	206.	950.	-	-	320.	-	-	-	-	-	-	-	80.
Bone-black,	92.	-	-	-	565.	-	-	-	-	-	-	-	73.
Double superphosphate,	115.	-	-	-	956.	-	320.	-	-	24.	-	-	12.
South American bone ash,	140.	-	-	-	718.	-	898.	-	-	-	-	-	90.
Acid phosphate,	285.	1399.	-	-	293.	-	-	-	-	-	-	-	216.
III. Refuse Substances.													
Dried blood,	239.	127.	210.	-	40.	-	-	-	-	-	-	-	-
Ammonite,	118.	-	227.	-	69.	-	-	-	-	-	-	-	28.
Oleomargarine refuse,	171.	288.	242.	-	18.	-	-	-	-	-	-	-	19.
Felt refuse,	585.	671.	105.	-	-	-	-	-	-	-	-	-	-
Sponge refuse,	145.	-	49.	-	64.	-	79.	25.	-	-	-	-	781.
Blood and bone,	167.	-	135.	-	220.	-	-	-	-	-	-	-	-
Horn shavings,	99.	-	306.	-	8.	-	-	-	-	-	-	-	-
Ivory dust,	230.	1053.	133.	-	491.	-	-	-	-	-	-	-	-

Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds — Continued.

	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
III. Refuse Substances — Continued.													
Horn and hoof waste,	203.	153.	265.	-	37.	-	-	-	-	-	-	-	5.
Raw wool,	139.	151.	258.	-	-	-	-	-	-	-	-	-	72.
Wool waste,	235.	582.	91.	34.	6.	-	2.	1.	16.	-	-	-	164.
Wool washings (water),	-	-	-	78.	-	10.	6.	-	-	-	-	-	-
Wool washings (acid),	-	-	-	84.	-	8.	12.	4.	-	-	-	-	-
Wool washings (alkaline),	1841.	66.	2.	22.	-	18.	1.	-	-	-	-	-	4.
Morocco factory waste,	454.	-	23.	7.	51.	-	392.	-	-	25.	-	-	483.
Meat scrap,	496.	-	127.	-	116.	-	-	-	-	-	-	-	-
Meat mass,	242.	272.	209.	-	41.	-	-	-	-	-	-	-	12.
Bone soup,	1658.	141.	23.	-	25.	-	-	-	-	-	-	-	-
Dried soup from meat and bone,	296.	168.	199.	-	11.	-	-	-	-	-	-	-	13.
Dried soup from rendering cattle feet,	216.	150.	289.	-	9.	-	-	-	-	-	-	-	5.
Dried soup from horse rendering,	1843.	-	22.	-	3.	-	-	-	-	-	-	-	-
Soap-grease refuse,	585.	1028.	64.	-	264.	-	-	-	-	-	-	-	26.
Bones,	137.	1061.	78.	-	447.	-	-	-	-	-	-	-	22.

Meat and bone,	105.	-	91.	-	404.	-	-	-	-	-	-	-	24.
Tankage,	191.	-	138.	-	230.	-	-	-	-	-	-	-	-
Fish with less than twenty per cent. water,	246.	430.	151.	-	170.	-	-	-	-	-	-	-	40.
Fish with between twenty and forty per cent. water,	604.	412.	119.	-	142.	-	-	-	-	-	-	-	34.
Fish with more than forty per cent. water,	909.	310.	99.	-	102.	-	-	-	-	-	-	-	27.
Whale meat, raw,	890.	21.	96.	-	-	-	-	-	-	-	-	-	-
Lobster shells,	145.	-	90.	-	70.	-	445.	26.	-	-	-	-	5.
Castor-bean pomace,	194.	114.	110.	31.	44.	-	17.	6.	-	-	-	-	35.
Cotton-seed meal,	136.	116.	135.	35.	33.	-	-	-	-	-	-	-	6.
Rotten brewers' grain,	1575.	-	15.	1.	17.	-	5.	3.	-	-	-	-	12.
Mill sweepings,	190.	-	75.	13.	24.	-	-	-	-	-	-	-	100.
Tobacco leaf,	261.	420.	55.	145.	9.	-	83.	43	6.	-	-	-	83.
Tobacco stems,	212.	281.	46.	141.	12.	7.	78.	25.	-	-	-	-	16.
Cotton waste, wet,	694.	-	26.	16.	31.	-	49.	23.	-	-	-	-	827.
Cotton waste, dry,	117.	1212.	35.	28.	9.	-	-	-	-	-	-	-	652.
Refuse from calico works,	81.	-	86.	-	239.	-	-	-	-	-	-	-	-
Cotton dust,	689.	1019.	10.	4.	4.	-	18.	18.	-	-	-	-	949.
Glucose refuse,	162.	-	52.	3.	6.	-	4.	.4	-	-	-	-	1.
Waste from lactate factory,	682.	-	14.	-	13.	-	452.	-	-	-	-	-	138.
Hop refuse,	180.	-	20.	2.	4.	-	5.	2.	-	-	-	-	13.
Banana skins,	280.	-	5.	109.	36.	-	-	-	-	-	-	-	-
Tankage and blood,	289.	-	118.	-	137.	-	-	-	-	-	-	-	-

Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds — Concluded.

	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
III. Refuse Substances — Concluded.													
Sumac waste,	1261.	136.	24.	65.	-	-	23.	65.	-	-	-	-	45.
Eel grass,	708.	312.	17.	18.	6.	33.	43.	2.	-	-	-	-	21.
Pine-barren grass,	170.	48.	3.	1.	4.	-	-	-	-	-	-	-	33.
Pine needles,	200.	68.	9.	1.	2.	-	-	-	-	-	-	-	24.
Rockweed, green,	1370.	474.	12.	-	-	-	-	-	-	-	-	-	-
Rockweed, dry,	214.	715.	29.	98.	55.	158.	153.	4.	-	-	-	-	208.
Jute waste,	262.	-	3.	2.	14.	-	-	-	-	-	-	-	-
Hair waste,	1456.	-	28.	6.	12.	-	-	-	-	-	-	-	-
Starch waste from rubber factory,	200.	5.	4.	-	-	-	-	-	-	-	-	-	-
Sludge from sewage precipitating tanks,	1770.	190.	1.	1.	2.	-	32.	8.	124.	-	-	-	19.
Sludge,	126.	-	14.	-	27.	-	173.	-	354.	-	-	-	761.
Residue from water filter,	1884.	-	2.	-	1.	-	-	-	-	-	-	-	-
Blue-green algæ (*Lyngbia majuscula*), dry,	325.	-	85.	16.	4.	71.	41.	24.	-	-	-	-	111.
Mussel mud, wet,	1200.	546.	4.	123.	2.	14.	19.	3.	70.	-	-	-	-
Mussel mud, dry,	45.	1440.	14.	-	7.	-	1468.	165.	-	-	-	-	752.

Madder,	239.	–	18.	48.	7.	–	79.	10.	–	–	–	–	93.
Salt mud,	1567.	824.	8.	7.	–	19.	18.	7.	83.	–	–	–	798.
Fresh-water mud,	807.	–	27.	4.	5.	–	25.	6.	36.	–	–	–	365.
Muck,	1194.	275.	18.	–	3.	–	–	–	–	–	–	–	227.
Peat, wet,	1227.	153.	17.	4.	2.	–	11.	14.	43.	–	–	–	43.
Peat, dry,	293.	345.	38.	1.	1.	–	–	–	–	–	–	–	203.
Turf,	386.	127.	39.	–	–	–	–	–	–	–	–	–	–
Soot,	86.	1542.	8.	13.	23.	–	60.	24.	128.	–	–	–	1321.
IV. Animal Excrement, etc.													
Barn-yard manure,	1340.	–	10.	11.	8.	–	6.	4.	–	–	–	–	162.
Horse manure,	225.	–	15.	56.	29.	–	–	–	–	–	–	–	252.
Sheep manure,	1205.	–	23.	33.	13.	–	–	–	–	–	–	–	258.
Drainage from manure heap,	1864.	73.	20.	18.	5.	–	–	–	–	–	–	–	–
Poudrette, dry,	105.	709.	72.	10.	115.	–	–	–	–	–	–	–	93.
Goose manure,	978.	–	4.	16.	19.	–	–	–	–	–	–	–	–
Hen manure, fresh,	1047.	49.	20.	5.	15.	–	24.	18.	–	25.	–	–	470.
Hen-house refuse,	69.	–	20.	12.	26.	–	–	–	–	–	–	–	–

4. Compilation of Analyses of Fruits, Garden Crops and Insecticides.

COMPILED BY H. D. HASKINS.

1. — Analyses of fruits.
2. — Analyses of garden crops.
3. — Relative proportions of phosphoric acid, potassium oxide and nitrogen in fruits and garden crops.
4. — Analyses of insecticides.

A computation of the results of a chemical analysis of twenty prominent garden crops shows the following average relative proportion of the three essential ingredients of plant food : —

	Parts.
Nitrogen,	2.2
Potassium oxide,	2.0
Phosphoric acid,	1.0

One thousand pounds of green garden vegetables contain, on the above-stated basis of relative proportion of essential constituents of plant food : —

	Pounds.
Nitrogen,	4.1
Potassium oxide,	3.9
Phosphoric acid,	1.9

The weight and particular stage of growth of the vegetables when harvested control, under otherwise corresponding conditions, the actual consumption of each of these articles of plant food. Our information regarding these points is still too fragmentary to enable a more detailed statement here beyond relative proportions. It must suffice for the present to call attention to the fact that a liberal manuring within reasonable limit pays, as a rule, better than a scanty one. — (C. A. Goessmann.)

1. *Analyses of Fruits.*

Fertilizing Constituents of Fruits.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Ericaceæ: —										
*Cranberries,	996	–	1.8	.9	.1	.3	.1	.3	–	–
*Cranberries,	894	.8	–	1.0	–	.2	.1	.3	–	–
Rosaceæ: —										
Apples,	831	.6	2.2	.8	.6	.1	.2	.3	.1	–
*Apples,	799	1.3	4.1	1.9	.3	.3	.3	.1	–	–
*Peaches,	884	–	3.4	2.5	–	.1	.2	.5	–	–
Pears,	831	.6	3.3	1.8	.3	.3	.2	.5	.2	–
Strawberries,	902	–	3.3	.7	.9	.5	–	.5	.1	.1
*Strawberries,	–	–	5.2	2.6	.2	.7	.4	1.0	–	–
*Strawberry vines,	–	–	33.4	3.5	4.5	12.2	1.3	4.8	–	–
Cherries,	825	–	3.9	2.0	.1	.3	.2	.6	.2	.1
Plums,	838	–	2.9	1.7	–	.3	.2	.4	.1	–
Saxifragaceæ: —										
*Currants, white,	–	–	5.9	3.1	.2	1.0	.3	1.1	–	–
*Currants, red,	871	–	4.1	1.9	.2	.8	.3	.9	–	–
Gooseberries,	903	–	3.3	1.3	.3	.4	.2	.7	–	–
Vitaceæ: —										
Grapes,	830	1.7	8.8	5.0	.1	1.0	.4	1.4	.5	.1
Grape seed,	110	19.0	22.7	6.9	.5	5.6	1.4	7.0	.8	.1

2. *Analyses of Garden Crops.*

Fertilizing Constituents of Garden Crops.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Chenopodiaceæ: —										
Mangolds, ...	880	1.8	9.1	4.8	1.5	.3	.4	.8	.3	.9
*Mangolds, ...	873	1.9	12.2	3.8	1.3	.6	.4	.9	–	–
Mangold leaves, . . .	905	3.0	14.6	4.5	2.8	1.6	1.4	1.0	.8	2.3
Sugar beets, ...	805	1.6	7.1	3.8	.6	.4	.6	.9	.3	.3
*Sugar beets, ...	869	2.2	10.4	4.8	.8	.6	.4	1.0	.1	–
Sugar-beet tops, . . .	840	2.0	9.6	2.8	2.3	.9	1.1	1.2	.2	.3
Sugar-beet leaves, . . .	897	3.0	15.3	4.0	2.0	3.1	1.7	.7	.8	1.3
Sugar-beet seed, . . .	146	–	45.3	11.1	4.2	10.2	7.3	7.5	2.0	1.9
*Red beets, ...	877	2.4	11.3	4.4	.9	.5	.3	.9	–	–
Spinach, ...	903	2.4	16.0	2.7	5.7	1.9	1.0	1.6	1.1	1.0
*Spinach, ...	922	3.4	9.6	9.6	2.1	.6	.5	.5	–	–
Compositeæ: —										
Lettuce, common, . . .	940	–	8.1	3.7	.8	.5	.2	.7	.3	.4
Head lettuce, ...	943	2.2	10.3	3.9	.8	1.5	.6	1.0	.4	.8
*Head lettuce, ...	970	1.2	–	2.3	.2	.3	.1	.3	–	–
Roman lettuce, ...	925	2.0	9.8	2.5	3.5	1.2	.4	1.1	.4	.4
Artichoke, ...	811	–	10.1	2.4	.7	1.0	.4	3.9	.5	.2
*Artichoke, Jerusalem, . .	775	4.6	–	4.8	–	–	–	1.7	–	–
Convolvulaceæ: —										
Sweet potato, ...	758	2.4	7.4	3.7	.5	.7	.3	.8	.4	.9
Cruciferæ: —										
White turnips, ...	920	1.8	6.4	2.9	.6	.7	.2	.8	.7	.3
*White turnips, ...	895	1.8	10.1	3.9	.8	.9	.3	1.0	1.0	–
White turnip leaves, . .	898	3.0	11.9	2.8	1.1	3.9	.5	.9	1.1	1.2
*Ruta-bagas, ...	891	1.9	10.6	4.9	.7	.9	.3	1.2	–	–
Savoy cabbage, ...	871	5.3	14.0	3.9	1.4	3.0	.5	2.1	1.2	1.1
White cabbage, ...	900	3.0	9.6	4.3	.8	1.2	.4	1.1	1.3	.5
*White cabbage, ...	984	2.3	–	3.4	.3	.2	.1	.2	–	–
Cabbage leaves, ...	890	2.4	15.6	5.8	1.5	2.8	.6	1.4	2.4	1.3
Cauliflower, ...	904	4.0	8.0	3.6	.5	.5	.3	1.6	1.0	.3
Horse-radish, ...	767	4.3	19.7	7.7	.4	2.0	.4	2.0	4.9	.3

Fertilizing Constituents of Garden Crops — Continued.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Cruciferæ — Concluded.										
Radishes,	933	1.9	4.9	1.6	1.0	.7	.2	4.5	.3	.5
Kohlrabi,	850	4.8	12.3	4.3	.8	.4	.8	2.7	1.1	.6
Cucurbitaceæ: —										
Cucumbers,	956	1.6	5.8	2.4	.6	.4	.2	1.2	.4	.4
Pumpkins,	900	1.1	4.4	.9	.9	.3	.2	.7	.3	.4
Gramineæ: —										
Corn, whole plant, green,	829	1.9	10.4	3.7	.5	1.4	1.1	1.0	.3	.5
*Corn, whole plant, green,	786	4.1	–	3.8	.5	1.5	.9	1.5	–	–
Corn kernels,	144	16.0	12.4	3.7	.1	.3	1.9	5.7	.1	.2
*Corn kernels,	100	18.2	–	4.0	.3	.3	2.1	7.0	–	–
*Corn, whole ears,	90	14.1	–	4.7	.6	.2	1.8	5.7	–	–
*Corn stover,	282	11.2	37.4	13.2	7.9	5.2	2.6	3.0	–	–
Leguminosæ: —										
Hay of peas, cut green,	167	22.9	62.4	23.2	2.3	15.6	6.3	6.8	5.1	2.0
*Cow-pea (*Dolichos*), green,	788	2.9	–	3.1	.6	3.0	1.0	1.0	–	–
*Small pea (*Lathyrus sylvestris*), dry.	90	38.5	–	25.7	4.7	17.9	5.0	9.0	–	–
Peas (seed),	143	35.8	23.4	10.1	.2	1.1	1.9	8.4	.8	.4
Pea straw,	160	10.4	43.1	9.9	1.8	15.9	3.5	3.5	2.7	2.3
Garden beans (seed),	150	39.0	27.4	12.1	.4	1.5	2.1	9.7	1.1	.3
Bean straw,	166	–	40.2	12.8	3.2	11.1	2.5	3.9	1.7	3.1
Liliaceæ: —										
Asparagus,	933	3.2	5.0	1.2	.9	.6	.2	.9	.3	.3
Onions,	860	2.7	7.4	2.5	.2	1.6	.3	1.3	.4	.2
*Onions,	892	–	4.9	1.8	.1	.4	.2	.7	–	–
Solanaceæ: —										
Potatoes,	750	3.4	9.5	5.8	.3	.3	.5	1.6	.6	.3
*Potatoes,	798	2.1	9.9	2.9	.1	.1	.2	.7	–	–
Potato tops, nearly ripe,	770	4.9	19.7	4.3	.4	6.4	3.3	1.6	1.3	1.1
Potato tops, unripe,	825	6.3	16.5	4.4	.3	5.1	2.4	1.2	.8	.9
*Tomatoes,	940	1.7	–	3.6	–	.3	.2	.4	–	–
Tobacco leaves,	180	34.8	140.7	40.7	4.5	50.7	10.4	6.6	8.5	9.4
Tobacco stalks,	180	24.6	64.7	28.2	6.6	12.4	.5	9.2	2.2	2.4
*Tobacco stems,	106	22.9	140.7	64.6	3.4	38.9	12.3	6.0	–	–

Fertilizing Constituents of Garden Crops — Concluded.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Umbelliferæ: —										
Carrots, ...	850	2.2	8.2	3.0	1.7	.9	.4	1.1	.5	.4
*Carrots, ...	898	1.5	9.2	5.1	.6	.7	.2	.9	–	–
Carrot tops, ...	822	5.1	23.9	2.9	4.7	7.9	.8	1.0	1.8	2.4
Carrot tops, dry, . . .	98	31.3	125.2	48.8	40.3	20.9	6.7	6.1	–	–
Parsnips, ...	793	5.4	10.0	.4	.2	1.1	.6	1.9	.5	.4
*Parsnips, ...	803	2.2	–	6.2	.1	.9	.5	1.9	–	–
Celery, ...	841	2.4	17.6	7.6	–	2.3	1.0	2.2	1.0	2.8

Most of the foregoing analyses were compiled from the tables of E. Wolff. Those marked * are from analyses made at the Massachusetts State Agricultural Experiment Station, Amherst, Mass.

3. *Relative Proportions of Phosphoric Acid, Potassium Oxide and Nitrogen in Fruits.*

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Ericaceæ: —			
*Cranberries, ...	1	3.0	–
*Cranberries, ...	1	3.4	2.6
Rosaceæ: —			
Apples, ...	1	2.7	2.0
*Apples, ...	1	1.9	1.3
*Peaches, ...	1	1.3	–
Pears.	1	3.6	1.2
Strawberries, ...	1	1.4	–
*Strawberries, ...	1	2.6	–
*Strawberry vines, . . .	1	.7	–
Cherries, ...	1	3.3	–
Plums, ...	1	4.3	–
Saxifragaceæ: —			
*Currants, white, ...	1	2.8	–
*Currants, red, ...	1	2.1	–
Gooseberries, ...	1	1.9	–
Vitaceæ: —			
Grapes, ...	1	3.6	1.2
Grape seed, ...	1	1.0	2.7

Relative Proportions of Phosphoric Acid, Potassium Oxide and Nitrogen in Garden Crops.

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Chenopodiaceæ: —			
Mangolds,	1	6.0	2.3
*Mangolds,	1	4.2	2.1
Mangold leaves,	1	4.5	3.0
Sugar beets,	1	4.2	1.8
*Sugar beets,	1	4.8	2.2
Sugar-beet tops,	1	2.3	1.7
Sugar-beet leaves,	1	5.7	4.3
Sugar-beet seed,	1	1.5	–
*Red beets,	1	4.1	3.3
Spinach,	1	1.7	3.1
*Spinach,	1	19.2	6.8
Compositeæ: —			
Lettuce,	1	5.3	–
*Lettuce,	1	7.6	4.0
Head lettuce,	1	3.9	2.2
Roman lettuce,	1	2.3	1.8
*Jerusalem artichoke,	1	2.8	2.7
Convolvulaceæ: —			
Sweet potato,	1	4.6	3.0
Cruciferæ: —			
White turnips,	1	3.6	2.3
*White turnips,	1	3.9	1.8
White turnip leaves,	1	3.1	3.3
*Ruta-bagas,	1	4.1	1.6
Savoy cabbage,	1	1.9	2.5
White cabbage,	1	4.1	1.7
*White cabbage,	1	11.0	7.6
Cauliflower,	1	2.3	2.5
Horse-radish,	1	3.9	2.2
Radishes,	1	3.2	3.8
Kohlrabi,	1	1.6	1.8
Cucurbitaceæ: —			
Cucumbers,	1	2.0	1.3
Pumpkins,	1	.6	.7
Gramineæ: —			
Corn, whole plant, green,	1	3.7	1.9
*Corn, whole plant, green,	1	2.2	2.8
Corn kernels,	1	.6	2.8
*Corn kernels,	1	.6	2.6
*Corn, whole ears,	1	.8	2.5
*Corn stover,	1	4.4	3.7

Relative Proportions of Phosphoric Acid, Potassium Oxide and Nitrogen in Garden Crops — Concluded.

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Leguminosæ: —			
Hay of peas, cut green,	1	3.4	3.4
*Cow-pea (*Dolichos*),	1	3.1	2.9
*Small pea (*Lathyrus sylvestris*),	1	3.4	4.2
Peas (seed),	1	1.2	4.3
Pea straw,	1	2.8	4.0
Garden beans (seed),	1	1.2	4.0
Bean straw,	1	3.3	–
Liliaceæ: —			
Asparagus,	1	1.3	3.6
Onions,	1	1.9	2.1
*Onions,	1	2.6	–
Solanaceæ: —			
Potatoes,	1	3.6	2.1
*Potatoes,	1	4.1	3.0
Potato tops, nearly ripe,	1	2.7	3.1
Potato tops, unripe,	1	3.7	5.3
*Tomatoes,	1	8.7	4.5
Tobacco leaves,	1	6.2	5.3
Tobacco stalks,	1	3.1	2.7
Tobacco stems,	1	10.7	3.8
Umbelliferæ: —			
Carrots,	1	2.7	2.0
*Carrots,	1	5.7	1.7
Carrot tops,	1	2.9	5.1
*Carrot tops, dry,	1	8.0	5.1
Parsnips,	1	3.8	2.8
*Parsnips,	1	3.3	1.2
Celery,	1	3.5	1.1

4. *Analyses of Insecticides.*

	Moisture.	Arsenious Oxide.	Copper Oxide.	Acetic Acid.	Nicotine.	Mercury.	Sulphur.	Sulphuric Acid.	Chlorine.	Calcium Oxide.	Potassium Oxide.	Ferric and Aluminic Oxides.	Matter Insoluble in Hydrochloric Acid.
Paris green,	1.30	62.55	32.84	3.10	-	-	-	-	-	-	-	-	0.21
Paris green,	1.41	61.40	33.20	3.90	-	-	-	-	-	-	-	-	0.09
Paris green,	1.40	61.15	33.10	3.71	-	-	-	-	-	-	-	-	0.64
Paris green,	1.15	53.91	31.27	8.10	-	-	-	-	-	-	-	-	0.04
Paris green,	1.34	61.25	33.35	3.93	-	-	-	-	-	-	-	-	0.13
Paris green,	1.31	61.21	33.45	3.94	-	-	-	-	-	-	-	-	0.09
Paris green,	1.15	59.92	30.40	-	-	-	-	-	-	-	-	-	0.10
Paris green,	1.27	54.80	30.85	6.50	-	-	-	-	-	-	-	-	0.12
"Sulphatine,"	1.40	-	2.61	-	-	-	48.28	4.73	-	18.60	-	-	1.63
"Death to Rose Bugs,"	2.95	-	1.05	-	-	-	34.53	4.35	-	17.76	-	-	0.49
"Professor De Graff's Carpet Bug Destroyer,"	95.81	-	-	-	-	0.78	-	0.48	0.27	-	0.26	0.90	-
"Oriental Fertilizer and Bug Destroyer,"	87.14	2.38	-	-	-	-	-	.64	3.00	-	3.50	-	-
"Non-poisonous Potato Bug Destroyer,"	-	-	-	-	-	-	-	-	-	68.20	-	1.38	1.50
Tobacco liquor,	37.71	-	-	-	2.12	-	-	-	-	3.07	6.55	0.23	-
Tobacco liquor,	40.89	-	-	-	0.53	-	-	-	-	1.47	16.34	0.01	-
Tobacco liquor,	-	-	-	-	4.55	-	-	-	-	-	-	-	-
Tobacco liquor,	-	-	-	-	4.82	-	-	-	-	-	-	-	-
"Nicotinia,"	10.00	-	-	-	-	-	-	-	-	4.45	9.15	-	2.12
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	2.34
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	38.12
"Peroxide of Silicate,"	1.65	0.57	0.33	-	-	-	-	49.66	-	41.18	-	-	2.31

As a rule, in all preceding analyses the essential constituents are determined and stated; blanks do not imply the absence of the non-essentials.

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THIRTY-FOURTH ANNUAL REPORT

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

JANUARY, 1897.

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Commonwealth of Massachusetts.

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, Jan. 1, 1897.

To His Excellency ROGER WOLCOTT.

SIR: — I have the honor to transmit, herewith, to Your Excellency and the Honorable Council, the thirty-fourth annual report of the trustees of the Massachusetts Agricultural College.

I am, very respectfully,
Your obedient servant,

HENRY H. GOODELL,
President.

30728

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CALENDAR FOR 1897–98.

1897.

January 6, Wednesday, winter term begins, at 8 A.M.

March 25, Thursday, winter term closes, at 10.15 A.M.

April 7, Wednesday, spring term begins, at 8 A.M.

June 19, Saturday, Grinnell prize examination of the senior class in agriculture.

June 20, Sunday, { Baccalaureate sermon. Address before the College Young Men's Christian Association.

June 21, Monday, { Burnham prize speaking. Meeting of the alumni. Flint prize oratorical contest.

June 22, Tuesday, { Class-day exercises. Military exercises. Reception by the president and trustees.

June 23, Wednesday, Commencement exercises.

June 24–25, Thursday and Friday, examinations for admission, at 9 A.M., Botanic Museum, Amherst; at Jacob Sleeper Hall, Boston University, 12 Somerset Street, Boston; and at Sedgwick Institute, Great Barrington. Two full days are required for examination, and candidates must come prepared to stay that length of time.

September 7–8, Tuesday and Wednesday, examinations for admission, at 9 A.M., Botanic Museum.

September 9, Thursday, fall term begins, at 8 A.M.

December 23, Thursday, fall term closes, at 10.15 A.M.

1898.

January 5, Wednesday, winter term begins, at 8 A.M.

March 24, Thursday, winter term closes, at 10.15 A.M.

ANNUAL REPORT OF THE TRUSTEES

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

His Excellency the Governor and the Honorable Council.

Thirty-five years ago, in the midst of the greatest struggle the world has ever witnessed, when every muscle was being strained to the utmost to provide means for preserving the national existence, our Senators and Representatives in Congress assembled, reversing the old adage, "In time of peace prepare for war," calmly turned aside from the absorbing topics of the day, and in time of war prepared for peace by passing an act for the benefit of agriculture and the mechanic arts, providing for the establishment of national schools of science in every State in this great country. They were to be *colleges*, in which it was explicitly declared the leading object should be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the Legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life. In such broad and liberal spirit, trammelled by few conditions, was framed this earliest act of Congress for the promotion of national popular education. In the words of the distinguished author himself, the Hon. Justin S. Morrill of Vermont, "the bill proposed to establish at least one college in every State, upon a sure and perpetual foundation, accessible to all, but especially to the sons of toil, where all the needful science for the practical avocations of life shall be taught, . . . and where agriculture, the foun-

dation of all present and future prosperity, may look for troops of earnest friends, studying its familiar and recondite economies, and at last elevating it to that higher level where it may fearlessly invoke comparison with the most advanced standards of the world."

From the sale of the 360,000 acres of the public lands, allotted to Massachusetts, was realized the sum of $208,464, and in 1871 this amount was further increased by the Legislature to $360,000, the whole constituting a perpetual fund for the promotion of education in agriculture and the mechanic arts, two-thirds of the income to be annually paid to the treasurer of the Agricultural College and one-third to the treasurer of the Institute of Technology.

Twenty-five years later, a second great act of Congress established in connection with each college a department of agricultural experimentation, at an annual expenditure of three-fourths of a million dollars.

Again three years, and the Hon. Justin Morrill, with whom had originated the first act, after a careful observance for twenty-eight years of the colleges he had been instrumental in establishing, came forward with a new measure for their endowment, by an annual grant to each one of the same amount, commencing with $15,000 and increasing each year $1,000 till the maximum of $25,000 had been reached, at which figure it was to remain without further increase. This again was divided in Massachusetts, one-third being paid to the Institute of Technology and two-thirds to this college.

Never was there a more munificent gift by a nation in the cause of education. First, ten million acres of the public lands, the proceeds from the sale of which to constitute an inviolable fund for the establishment and maintenance of at least one college in every State which should accept the grant; second, an annual appropriation of three-quarters of a million dollars for purposes of investigation and experimentation in all matters pertaining to the intelligent practice of agriculture; third, an annual appropriation of one million dollars for further maintenance and support. It was a fortunate period in which these colleges were established. The rapid development of the various branches of mechanical

and physical science had been accompanied by a corresponding application of them in industrial pursuits and a consequent demand for thoroughly trained and competent men. In the hearing before the committee on education this effect was briefly epitomized. The result was that large numbers of the most promising youth of the country were drawn to these institutions which opened up so many possibilities. This movement gave an impulse which was felt by every school of science in the country. It forced new methods of instruction to meet the constantly increasing demand. It compelled expensive outlays for equipment which should keep pace with this new and practical education of the people. It was the "awakening of a new intellectual life, and there was a certain freshness of interest, a spirit of youth, a generous enthusiasm, which argued the happiest results, and which time has only strengthened as the years roll on." The pet idea of Ezra Cornell, that he would "found an institution where any person could find instruction in any study," would seem to be realized. To-day 65 colleges, thoroughly equipped with laboratories and workshops, and provided with the latest and most approved apparatus, officered by 1,600 professors and instructors, shelter within their walls an army of young men 21,000 strong. Twenty-one regiments, captained and led by the best and keenest intellects available, are all making for progress and development along certain well-defined lines. Five, planting their outposts in every nook and corner of the vast domain of nature, are calling upon the earth, the air, the water to give up their secrets. Sixteen are pushing their way in the various industries, but each and all are making instantly felt the contact of a new and vigorous life and awakening fresh enterprise and fresh effort. Many of the youth composing this vast army receive their entire support from home, but many others are supporting themselves by their own exertions, almost or wholly unaided, and many others come from homes where every dollar contributed to the education of a son or daughter involves some appreciable sacrifice. "They are all acquiring habits of industry, energy and self-reliance. They represent more fully than any other class of institutions the real bone and sinew and brain of the

country. They represent in no small degree the brain and purpose of the coming generation. They represent the great body of the people, from which are very largely recruited the best elements of our political, our social and industrial activities." *

Thirty years ago this year the Massachusetts Agricultural College first opened its doors to students, and in this the closing year of its third decade of existence it seems pertinent to inquire whether it has warranted the generous outlay of nation and State for its support, — whether it has fulfilled the purpose for which it was founded, and sent forth honest, manly citizens to serve their country and their State and adorn the different trades and professions of life. The wealth of a college is the life of her sons, and her success is measured by the success of her sons.

In its brief history of one score years and ten, 1,096 men have attended the college and 510 have graduated; 87 have passed away, 15 only from among the graduates and 72 from the remainder. Of the living, 348 are in agricultural pursuits distributed as follows: farmers, 186; farm superintendents, 23; market gardeners and florists, 46; veterinarians, 16; creamery managers, 6; stock and poultry raisers, 10; entomologists, 8; officers in experiment stations, 19; in the fertilizer business, 12; teachers in agricultural colleges, 22. Other industries are represented by chemists, 9; civil engineers and architects, 43; electricians, 10; mechanics, 40; employed on railroads, 15; dentists, 6; druggists, 7; teachers, 34; ministers, 8; students for advanced degrees, 39; postal clerks, 7; doctors, 40; journalists and publishers, 18; in the army and navy, 5; lawyers, 20; and in business, 270. Our graduates are found in every State, filling positions of honor. The record is a good one. We have furnished Japan with 1 president and 7 professors. We have given presidents to Rhode Island and North Dakota and a vice-chancellor to Indiana. We have sent 5 professors to Rhode Island, 2 each to Alabama, Michigan, Ohio, Mississippi, Missouri, Tennessee, Indiana, Connecticut and New Hampshire, and 1 each to Delaware, Minnesota,

* From the speech of President George W. Atherton, before the naval committee.

Illinois, Virginia, Maine, Colorado, Texas and Maryland. Yale has drawn upon our lawyers for an instructor in criminal law and medico-legal jurisprudence, Harvard has called our graduates to her veterinary and dental schools, and Canada has found a botanist for Magill University. We have furnished the vice-director to the office of experiment stations at Washington, and directors to Indiana, North Dakota, Vermont, Rhode Island and Brazil, besides filling 63 other positions in the different experiment stations of the country.

Thirty years ago, with a staff of five instructors and four buildings, without a library, without appliances of any sort, the college opened its doors to the 27 young men who presented themselves for admittance. To-day, if one of these same young men should revisit the college, he could but marvel at the change. He will find an opportunity of securing a maximum education at a minimum cost, tuition free, board at a trifling figure and work to be had for the asking, if the necessities of his case demand such aid. He will find a farm of 150 acres under cultivation, with model barn stocked with 100 head of cattle and equipped with the latest and most improved machinery. He will find a horticultural department of 100 acres, with greenhouses, orchards and grounds laid out for the practical study of market gardening, floriculture, fruit culture and forestry. He will find an experiment department, some 80 acres in extent, with laboratories, greenhouses, insectaries and barns, where are being worked out all conceivable problems in the use of fertilizers, in the feeding of animals, in soil investigations, plant diseases, testing of fruits and vegetables, prevention of insect ravages, and relations of temperature and moisture to growth. He will find a growing library of 18,000 carefully selected volumes, almost entirely scientific in its character and well abreast of the literature of the day, in which he will not only be invited and urged to enter, but to which he will be sent to look up information for himself, and taught how to investigate any given subject and to weigh and value the testimony of authorities. He will find a corps of 18 professors and assistants, each doing faithfully and conscientiously the work assigned him. He

will find a certain definite required curriculum for three years, with liberty to select and specialize in the fourth; and together with this, eleven short winter courses especially adapted to the requirements of those whom circumstances debar from spending a longer time in the prosecution of their studies. He will find a superstructure of agricultural education, reared somewhat after this fashion: agriculture the foundation; botany, chemistry, zoölogy and mathematics the four corner-stones; while the walls are solidly built up with English, horticulture, floriculture and forestry on the one side, English, physiology, entomology, comparative anatomy of the domestic animals and veterinary on the other, English, mechanics, physics and civil engineering on the third, and English, French, German, political economy and constitutional history on the fourth. The study of his own language, he will find, is made the basis of all study, interwoven with every course, in fact, the very warp and woof of every branch pursued. If he wants to become a farmer, a market gardener or a fruit grower, he will find the appliances at hand and every opportunity to become conversant with the art. If he wants to become a good chemist, every facility will be given him. If he wants to become a good botanist, few places will offer him better instruction. If he wants to become a good entomologist, he will have to search the length and breadth of the land to find equal opportunities. If he wants to become a good civil engineer, the foundations will be laid for him deep and strong. And he will further find, if he inquires, that the course covers such extensive ground in botany, chemistry, physiology and allied branches that graduates entering veterinary or medical schools stand at a great advantage, and in the former case are allowed one year's time. In fact, he will find that the whole aim and purpose of the college has been to so educate its students as to prepare them to play well their part in the "several pursuits and professions of life."

The State has indeed been fortunate in the selection of those to whom it has intrusted the welfare of its college. To the great-hearted men who have carried on this work all credit is due. But for the self-denying, whole-souled efforts

of its faculty, such record could never have been written. The living force of men like Clark and Stockbridge and Miller and Peabody and Chadbourne has made it what it is. Their influence can never die.

In the year just elapsed we have been called to mourn the loss of one who has faithfully served the college since 1887. Hon. Joseph A. Harwood of Littleton passed away Oct. 15, 1896. A man of large business interests and wide experience, he held many public offices. Extensively engaged in farming and stock raising, he took an active, intelligent interest in the affairs of the college, conscientiously performing every duty assigned him. In expression of their esteem, the trustees of the college at the first meeting held after his death passed the following resolutions: —

Whereas, Death has removed our associate, Col. Joseph A. Harwood of Littleton, October, 1896, for ten years a member of the Board of Trustees of the Massachusetts Agricultural College, therefore, be it

Resolved, That we now, in annual meeting assembled, place on our records our expression of the high appreciation of his services on the Board, and the esteem in which we shall always hold his memory.

Resolved, That these resolutions be incorporated in the report of the trustees, and that a copy be transmitted to his family.

His place on the Board was filled by the appointment of Charles L. Flint of Brookline. Francis H. Appleton having resigned, Nathaniel I. Bowditch of Framingham was appointed to serve for the remainder of his term.

The several appropriations made by the State have been carefully expended for the purposes named. The Clark property, embracing some 20 acres, has been purchased, and the ground partially prepared for setting out orchards. The addition to the laboratories of the experiment department has been satisfactorily completed. By prolonging the two wings 55 feet, joining them by a transverse section and throwing a sky-light over the intervening space, 1,220 square feet additional room has been secured, much needed for work, and about the same additional space for storing apparatus when not in use, and for exhibiting fertilizer and

concentrated food material. The heating apparatus is being rapidly put in position, and a new and improved gas machine, fitted up with a mixing regulator of air and gas, has been purchased. The increasing demands upon the department for analyses of fertilizers and fertilizing materials, water, dairy products and feeds can now be more promptly and efficiently satisfied.

It is too early yet to ascertain how far the eleven short winter courses established this year meet the requirements of those whose circumstances forbid a longer stay at the college. The effort has been made to make them as practical as possible, along such lines as experience has shown to be most helpful. To benefit the many and "to give instruction," as is finely written over one of the archways in the great library at Washington, "to those who cannot procure it for themselves" is the sole aim of these winter courses. In the brief time allotted, the instruction must be more or less elementary in its character; but the double courses provided permit concentrated attention upon a given subject in one year, or continuous study in successive years. The increasing activity of women in the industrial pursuits, and the consequent demand for instruction, has led to the opening of special elective courses for them, in such branches as botany, entomology, floriculture, fruit culture, market gardening and the dairy.

The success attending the elective courses of the senior year has been so marked that an effort is being made, while in no wise departing from the purpose for which the college was founded, to specialize at an earlier point in the course. It is hoped that before another twelve months the adjustment of related studies will have been completed, and the plan submitted for your approval. The study of descriptive geometry in the winter term of junior year has been discontinued, and in its place has been substituted a course of practical work in laboratory physics. An elective course of lectures in history is offered to the senior class.

The two subjects at the present moment lying uppermost in the minds of the farmers and horticulturists of this State are plant diseases and animal diseases. No other questions are of such vital importance; no others affect them more

closely. The changed and in some respects unnatural conditions, resulting from forcing plants to produce bloom and fruit out of season, have resulted in the introduction of a large number of new diseases, with which growers under glass find themselves unable to cope. Mildews, fungous growths, nematodes are all doing their deadly work, and many cases have been reported to us where fully one-half the entire crop of cucumbers, tomatoes or lettuce has been ruined. The same holds true in the raising of pinks, violets, roses and other flowers for the market. Statistics show that in 1891 there were 562 persons in Massachusetts engaged in nurseries alone, that some $6,000,000 capital was invested in greenhouses, orchards and nurseries, and that the damage annually done by disease and insect foes was rapidly increasing. The demands made upon college and station for information and relief are unceasing. Scarcely a day passes but diseased plants, spotted leaves or nematode-affected roots are sent in for examination and determination. The college should be in condition to promptly respond to these cries for aid; but the appliances at hand are altogether too meagre for the vast field of inquiry which has been opened. *Common-sense* is a first-class physician, and can take care of the ordinary mumps or measles or scarlet-fever form of disease to which plants are subject; but when it comes to tracing out some new and obscure ailment, trained men are needed. These diseases can only be studied by specialists. They must first be investigated in the laboratory and their life histories made out, and afterwards the different remedies applied in the greenhouse, where the conditions of light, heat, moisture, etc., are under control. The glass houses already on the grounds were built for other ends, and have each their specific work to perform; they cannot be utilized for this purpose. The one attached to the division of vegetable pathology and plant disease is entirely inadequate for such investigations, and requires complete renovation to put it in effective condition. To change its position so that it shall receive the full benefit of the morning and afternoon light, to thoroughly reconstruct and equip it, so that experimentation can be carried on with different diseases at the same time, an appropriation of $1,500 is asked. This

amount is based upon plans and contract prices already submitted. The study of botany has entirely changed in character during the last few years. The great object which Bacon proposed to himself in setting forth the advantages of the inductive method of philosophy was *fruit*, the improvement of the condition of mankind. So, now, the study of botany is approached from its utilitarian side, from that side which shall bear fruit and be helpful to mankind. The microscopic structure of the plant itself, the acquaintance with the lower forms of fungous growth, the recognition of disease, have become such important factors that a class room without a laboratory, where the pupil can dissect and investigate for himself, is like a carpenter endeavoring to work without tools. The agricultural college should be especially prepared to give such instruction. Its laboratory, however, is so small that it is found impossible to accommodate a class of over a dozen. Three years ago, before the wants of the department were properly estimated, an appropriation of $200 was asked and granted. It was, however, found to be so entirely inadequate that it was covered back into the State treasury. An appropriation of $1,200 is now asked, to enlarge the laboratory 18 feet, furnish proper light and ventilation and provide the necessary stands and equipment.

Census returns in 1890 place the valuation of domestic animals in this country at over two billion dollars, and it has been computed that there is an annual loss of six per cent. resulting from disease, most of which is preventable. One hundred and twenty million dollars lost annually through carelessness, ignorance or disregard of nature's laws! In 1896 there were in this State 174,167 cows and 38,434 neat cattle other than cows. Horses, sheep and swine swell the total to 485,830 animals. An annual six per cent. loss on the sixteen million dollars valuation of this stock, most of which we are told is preventable, is surely too high a price to pay for lack of knowledge. The report of the veterinarian so clearly sets forth the necessity of providing facilities for enlarging the scope of his department and improving it along certain lines for the benefit of student and citizen that I incorporate it as a part of my report: —

At present the equipment of the department consists of an exceptionally complete collection of papier-maché models, several dissections, dry and alcoholic preparations of normal and diseased tissues, and some charts for class-room work, together with a small room 12 by 15 feet for a laboratory. This contains apparatus consisting of incubator, hot-air and steam sterilizers, microtome, microscope, etc., necessary for ordinary bacteriological and pathological *laboratory* work. The room, being small and having only one window, affords working space for a single person. The nature of the work possible under existing conditions is limited by the want of a suitable place in which to keep such animals as are indispensable for original investigation. The laboratory and its equipment, primarily intended simply for preparing material for the class room, have been employed as far as possible in carrying on the investigations conducted by the department, the results of which have been published in the bulletins of the Hatch Experiment Station. In the past, considerable quantities of material from diseased animals have been sent in by farmers and other persons from various localities in the State. This has been examined, and a report of the same, with brief mention of the cause, means of treating, arresting or preventing the disease, returned to the sender. In those cases where it has been necessary to use animals for experiment in the study required, I have been obliged to keep them in the cellar of my house, for want of a place at the college. With the present arrangements, the simple microscopic study of material is all that can be carried on successfully.

That portion of the Zoölogical Museum set apart for the use of the veterinary department is full to overflowing. There are valuable specimens on hand that cannot be put on exhibition for the want of space. Much that has been placed in the cases cannot be seen to good advantage, owing to the crowded condition.

Briefly stated, under existing conditions the department is confined to two lines of work, viz., instruction to the students in the class room and simple laboratory examinations of such specimens as are sent in by farmers and others. In connection with the former, the material in the museum is utilized for purposes of illustration. Occasional clinical demonstrations are held.

An increase to the equipment of the department would greatly enlarge the scope and value of its work. The first requisite is a laboratory building, including suitable quarters for small animals to be used in experiment. It should also contain a museum, a lecture room, and such accessory rooms as are always necessary in a building of this description. So far as I am aware, there does not exist a place in the State having for its prime object the study

of the diseases of the domestic animals. I believe investigations could be made in this line of work at the college, to the great advantage of students, stock owners and veterinarians. Although no special effort has been made to encourage farmers to send material from diseased animals for examination, there have been received from time to time a considerable number of specimens. This division of the work would be enlarged, and valuable assistance rendered the stock raisers and dairymen. There are many of the more remote rural districts in which the services of a competent veterinarian are not available; in such places the veterinary department of the college could render assistance without doing the practitioner an injustice. Aside from such service rendered directly to the farmer, the same plan could be followed with the veterinarians throughout the State. It frequently happens that there occur in practice obscure cases which the average practitioner has neither the time nor the apparatus to investigate. This is particularly true with some of the contagious diseases, not under control of the State Board of Cattle Commissioners, in which inoculation experiments and careful microscopic examinations are essential to a speedy and correct diagnosis.

In the teaching of veterinary science, as in all others, the "objective method" is particularly valuable. It is impossible for a student to recognize a disease of which he has only a class-room knowledge. Practical demonstration is essential. The use of material sent in during the past few years has proved of great benefit to the students. A laboratory in which each one could study for himself such specimens, as well as the form and habits of the disease producing micro-organisms, would increase the value of the department greatly. To familiarize the agricultural student with the causes, symptoms, diagnosis and prevention of those common maladies which are hereditary and preventable, to familiarize him with the causes, means of propagation and prevention of animal plagues, should be the chief aim in teaching this science in agricultural colleges. This can only be done by combining practical laboratory work with class-room exercises.

With the development of the subject of diagnosis and treatment of disease by the use of bacterial products, the department might properly undertake, for distribution among the farmers, the preparation of such of these substances as should be proven of value. The "bacteriology of the dairy" has been during the past few years the subject of careful study. The good results obtained thus far would seem to indicate the necessity for more extended experiment and research.

From what has already been urged, it must be apparent that

more extended quarters are needed for museum purposes. Situated as the college is, in a comparatively small town, the amount of clinical material is necessarily limited, so that at the desired time it is frequently impossible to obtain the fresh specimens needed to supplement class-room work. Under such circumstances a well-stocked museum is indispensable to obtain satisfactory results.

Believing that there is a growing demand for the study of animal pathology and bacteriology, and that the benefits accruing to students, stock raisers, dairymen, poultry producers and others interested in animal industry would be of sufficient magnitude to warrant the cost of construction of suitable buildings and the equipment of the same, I hereby petition the trustees of the college to take the steps requisite for procuring the funds needed to provide the same.

Respectfully submitted,

JAS. B. PAIGE,

Veterinarian.

Plans for buildings especially adapted for this purpose — a laboratory with lecture room and culture room, equipped and complete, with cages for keeping the smaller animals on which experiments are to be tried; a barn, so constructed that patients can be absolutely isolated, and built of such material as to ensure perfect disinfection — would demand a large outlay. The magnitude of the interests at stake, the great value to the community at large, the importance in an educational point of view, warrant such appropriation. It is hoped that at no distant day it may be realized.

Adequate water supply is one of the first requisites in all civilized communities, whether for purposes of sanitation or protection from fire. The present system, inaugurated at the college some twenty-five years ago, fails utterly in both respects. Corrosion and tuberculation of the pipes, and frequent breakages of the main, leave the college at times without any supply whatsoever, so that, if a fire should break out, not a drop of water would be available for the protection of buildings erected by the State at an expense of a quarter of a million of dollars. The diameter of the pipes, only three inches, is entirely too small for the protection of buildings scattered over an area a mile in extent. Twice it has happened that the college has been left without water, for

protection from fire, for washing purposes and flushing of the closets, and for the boilers of the electric light plant. It is not only a menace to the health of the students, but a constant danger from fire. The full details are set forth in the report of our civil engineer, herewith submitted: —

AMHERST, MASS., Jan. 4, 1897.

President HENRY H. GOODELL.

DEAR SIR: — I submit to you herewith a report of my investigation of the Massachusetts Agricultural College water supply and fire protection, made in accordance with your request.

PRESENT HYDRANT PRESSURE TESTED.

Dec. 12, 1896, with the assistance of Lieutenant Wright and Mr. Wallace, I tested the water pressure at all of the college hydrants, the method of testing employed being as follows: a siamese, two-way gated coupling, kindly loaned by the Amherst fire department, with a pressure gauge on one of its branches, was attached to the hydrant. By means of it the static pressure at the hydrant was observed, after which fifty feet of rubber-lined hose of fair quality, with one and one-eighth inch conical "smooth" nozzle, was attached to the free branch of the siamese coupling. The water was then allowed to flow, and its pressure at the hydrant was observed again, with the one stream flowing, and note was made of the character and force of the fire stream. From this data was computed the quantity of water discharged per minute. The result of the test of the six above-mentioned hydrants is shown in Table A.

TABLE A. — *Test of Hydrant Pressure.*

LOCATION OF HYDRANT.	Static Pressure (Pounds per Square Inch).	PRESSURE AND QUANTITY AT HYDRANT.*		Horizontal Distance Stream thrown (Feet).	Character.
		Pressure (Pounds).	Gallons per Minute.		
Lower barn (M. A. C.) hydrant, .	110	18	135±	50	Broken and no good.
North college (back of) hydrant, .	97	22	150±	60+	Broken and no good.
South college hydrant, . . .	92	21	150±	75	Broken and no good.
Drill hall hydrant, ...	88	21	150±	75	Broken and no good.
Plant house (Durfee) hydrant, .	80	36	190±	90	Broken and no good.
Town hydrant, near Bangs house,	87	58	240+	150 to 175	Good.

* With one stream running through fifty feet of two and one-half inch hose and one and one-eighth inch smooth nozzle.

NOTE. — A good fire stream consists of a discharge of 240 to 250 gallons per minute (through a one and one eighth inch nozzle).

In comment thereon it should be said that at not a single one of the college hydrants was an adequate pressure or quantity of water obtained. With the exception of the stream at the plant house hydrant, which was an indifferent one, all were "feeble" or "very feeble" fire-streams. At the water company's hydrant alone (situated near the Bangs house), of all those tested, was a good fire-stream obtained. It will be further observed, that the valuable Hatch station buildings, laboratories and barns are *absolutely without* fire protection, there being no hydrants nearer than north college, the one and one-quarter inch (reduced to one inch) pipe leading to the station being too small even to supply the laboratories and lavatories at the same time, much less to furnish a fire-stream with which to protect the buildings. The boarding-house, Hatch barn and the Walker's house are in the same plight, while the position of the library and other college buildings, with the present pipe system, is little better.

Cause of Inadequate Hydrant Pressure.

The cause of our insufficient water supply is to be found in the small size of our pipes, which under a considerable draught of water so reduce the water pressure, through frictional losses, as to make it impossible to obtain a single good fire-stream at any of the hydrants. It might also be added that the carrying capacity of the present wrought-iron pipe system has no doubt been considerably reduced by corrosion and tuberculation of the inner surfaces of the pipes. The whole college supply is at present delivered through a three-inch wrought-iron pipe laid about twenty years ago, badly corroded, leading from the water company's six-inch main near the Stockbridge house to the drill hall, thence by a four-inch main to the north college hydrant, where it divides, one three-inch branch leading to the barn, the other branch, a two-inch pipe, reduced to one and one-quarter inch (and then one inch), supplying the boarding-house and Hatch station. The plant house, too, is supplied by a three-inch main, which is reduced to one inch leading therefrom to the museum, barn and Professor Maynard's house.

Remedy.

The remedy for our insufficient water pressure is perhaps obviously the substitution of pipes of larger diameter for our present mains. The present pipes need not be disturbed, but new and larger mains are absolutely necessary, if adequate fire protection is to be obtained. Briefly stated, the proposed changes consist

of tapping the water company's main at the junction of the roads near the insectary, and laying a six-inch pipe from this point to the Hatch Experiment Station buildings by way of the road leading by the south end of the pond, past the library, south college, north college and over the ravine to the Hatch station, where the size of the pipe will be reduced to four inches in diameter leading to the feeding barns, etc., on the county road beyond the station. A six-inch branch will be laid to the college barn, with four-inch branches at its extremities, supplying hydrants on the north and south side of the barn. A four-inch branch will be laid to a hydrant opposite the boarding-house, and the water company's six-inch main near the Stockbridge house will be continued to a hydrant near the north-west corner of the botanic museum. Additional hydrants and gates will of course be required and are shown in detail on the plan.

Cost.

The following table (Table B) gives a summarized account of the probable cost of the required improvements, in which is included the purchase of new hose: —

Table B. — *Estimate of Cost of Improvements.*

5,250 feet six-inch cast-iron pipe and specials, furnished and laid,	$3,675 00
1,600 feet four-inch cast-iron pipe and specials, furnished and laid,	800 00
Service-pipe work, new connections, tapping, etc.,	200 00
11 hydrants,	275 00
7 six-inch gates and 2 four-inch gates,	90 00
500 feet hose, fittings, etc.,	300 00
Engineering and supervision ten per cent., nearly, on construction,	460 00
Total,	$5,800 00

Further Improvements advised.

In addition to the above-mentioned improvements, which are deemed imperative, the advisability of still further perfecting our system by the construction of a small reservoir on the hill east of the plant house, and connecting it with our pipe system by a six-inch main, suitably gated, is urged upon you.

The necessity for such a reservoir is found in the inconvenience and danger to which we have been and are repeatedly subjected by the temporary discontinuance of the town water supply, due to breaks in the town main, etc. On several occasions during the past year the college water supply has given out suddenly, and been shut down for so long a period as to necessitate the drawing of fires in our boilers, the shutting down of our electric lighting and power plant, the serious fouling of sewers and closets, with attendant offensiveness and danger of causing sickness among the students, etc., and rendering us absolutely powerless in the event of fire. All of this might be obviated by the construction of a small reservoir on the hill, of a capacity of several days' water supply, which would tide us over the discontinuance of the town water supply, furnishing us not only with the water ordinarily required, but also with a limited fire supply. The additional cost of such improvements would be about $2,500.

Conclusion.

In conclusion, I desire to urge upon you again the advisability of making the first-mentioned improvement, at least. For fire protection our present system is but one step removed from the old-fashioned well and bucket system, in that, while we can get *some* water through a hose, we cannot get it in sufficient quantity or under effective pressure. The long list of past fires at the college, with its attendant losses, is certainly suggestive, if not impressive. Among the buildings wholly or partially destroyed by fire in the past twenty years are the following: the Durfee plant house, main building, was completely destroyed by fire about fourteen years ago; south college, entirely destroyed about eleven years ago; north college has passed through several small fires; the M. A. C. barn was completely destroyed a few years ago, — as was one of the Hatch barns a few years before it. Besides these, there have been numerous other small blazes, unnecessary to chronicle at this time.

Certainly with our present pipe system the hope of making effective resistance against fire is very small.

Respectfully submitted,

LEONARD METCALF.

Recapitulating briefly, the following appropriations are asked: —

1. For renovating the greenhouse in the experiment department of plant disease,	$1,500
2. For increasing the educational facilities for teaching botany by providing laboratory room,	1,200
3. For painting and renovating the old greenhouses,	1,000
4. For providing adequate water supply, laying one mile of six-inch pipe and building a reservoir to be used in emergencies,	8,300
Total,	$12,000

Respectfully submitted, by order of the trustees,

HENRY H. GOODELL,
President.

AMHERST, Jan. 1, 1897.

THE CORPORATION.

	Term expires.
JAMES S. GRINNELL of GREENFIELD,	1898
CHARLES L. FLINT of BROOKLINE,	1898
WILLIAM H. BOWKER of BOSTON,	1899
J. D. W. FRENCH of BOSTON,	1899
J. HOWE DEMOND of NORTHAMPTON,	1900
ELMER D. HOWE of MARLBOROUGH,	1900
NATHANIEL I. BOWDITCH of FRAMINGHAM,	1901
WILLIAM WHEELER of CONCORD,	1901
ELIJAH W. WOOD of WEST NEWTON,	1902
CHARLES A. GLEASON of NEW BRAINTREE,	1902
JAMES DRAPER of WORCESTER,	1903
SAMUEL C. DAMON of LANCASTER,	1903
HENRY S. HYDE of SPRINGFIELD,	1904
MERRITT I. WHEELER of GREAT BARRINGTON,	1904

Members Ex Officio.

HIS EXCELLENCY GOVERNOR ROGER WOLCOTT,
President of the Corporation.

HENRY H. GOODELL, *President of the College.*

FRANK A. HILL, *Secretary of the Board of Education.*

WILLIAM R. SESSIONS, *Secretary of the Board of Agriculture.*

JAMES S. GRINNELL of GREENFIELD,
Vice-President of the Corporation.

GEORGE F. MILLS of AMHERST, *Treasurer.*

CHARLES A. GLEASON of NEW BRAINTREE, *Auditor.*

Committee on Finance and Buildings.*

JAMES S. GRINNELL. HENRY S. HYDE.
J. HOWE DEMOND. SAMUEL C. DAMON.
CHARLES A. GLEASON, *Chairman.*

Committee on Course of Study and Faculty.*

WILLIAM H. BOWKER. ELMER D. HOWE.
CHARLES L. FLINT. J. D. W. FRENCH.
WILLIAM WHEELER, *Chairman.*

Committee on Farm and Horticultural Departments.*

ELIJAH W. WOOD. JAMES DRAPER.
NATHANIEL I. BOWDITCH. MERRITT I. WHEELER.
WILLIAM R. SESSIONS, *Chairman.*

Committee on Experiment Department.*

CHARLES A. GLEASON. ELIJAH W. WOOD.
WILLIAM WHEELER. JAMES DRAPER.
WILLIAM R. SESSIONS, *Chairman.*

Board of Overseers.

STATE BOARD OF AGRICULTURE.

Examining Committee of Overseers.

A. C. VARNUM (*Chairman*), . of Lowell.
GEORGE CRUICKSHANKS, . of Fitchburg.
E. A. HARWOOD, . . . of North Brookfield.
JOHN BURSLEY, ... of West Barnstable.
C. K. BREWSTER, . . . of Worthington.

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* The president of the college is ex officio a member of each of these committees.

The Faculty.

HENRY H. GOODELL, LL.D., *President*,
Professor of Modern Languages.

LEVI STOCKBRIDGE,
Professor of Agriculture, Honorary.

CHARLES A. GOESSMANN, Ph.D., LL.D.,
Professor of Chemistry.

SAMUEL T. MAYNARD, B.Sc.,
Professor of Horticulture.

CHARLES WELLINGTON, Ph.D.,
Associate Professor of Chemistry.

CHARLES H. FERNALD, Ph.D.,
Professor of Zoölogy.

Rev. CHARLES S. WALKER, Ph.D.,
Professor of Mental and Political Science.

WILLIAM P. BROOKS, B.Sc.,*
Professor of Agriculture.

GEORGE F. MILLS, M.A.,
Professor of English and Latin.

JAMES B. PAIGE, D.V.S.,
Professor of Veterinary Science.

LEONARD METCALF, B.S.,
Professor of Mathematics and Civil Engineering.

GEORGE E. STONE, Ph.D.,
Professor of Botany.

HERMAN BABSON, M.A.,
Assistant Professor of English.

EDWARD R. FLINT, Ph.D.,
Assistant Professor of Chemistry.

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* On leave.

FRED S. COOLEY, B.Sc.,
Assistant Professor of Agriculture.

RICHARD S. LULL, B.S.
Assistant Professor of Zoölogy

RALPH E. SMITH, B.Sc.,
Instructor in German and Botany.

PHILIP B. HASBROUCK, B.S.,
Assistant Professor of Mathematics.

WILLIAM M. WRIGHT, 1st Lieut., 2d Infantry, U.S.A.,
Professor of Military Science and Tactics.

ROBERT W. LYMAN, LL.D.,
Lecturer on Farm Law.

HENRY H. GOODELL, LL.D.,
Librarian.

Graduates of 1896.*

Master of Science.

Kirkland, Archie Howard, . . .	Norwich.
Smith, Frederic Jason, . . .	North Hadley.

Bachelor of Science.

Burrington, Horace Clifton (Boston Univ.), ...	Charlemont.
Clapp, Frank Lemuel (Boston Univ.),	Dorchester.
Cook, Allen Bradford (Boston Univ.),	Petersham.
De Luce, Francis Edmond (Boston Univ.), ...	Warren.
Edwards, Harry Taylor (Boston Univ.),	Chesterfield.
Fletcher, Stephen Whitcomb (Boston Univ.), ...	Rock.
Hammar, James Fabens (Boston Univ.), ...	Swampscott.
Harper, Walter Benjamin, . . .	Wakefield.
Jones, Benjamin Kent (Boston Univ.),	Middlefield.

* The annual report, being made in January, necessarily includes parts of two academic years, and the catalogue bears the names of such students as have been connected with the college during any portion of the year 1896.

Kinney, Asa Stephen (Boston Univ.),	Worcester.	
Kramer, Albin Maximilian (Boston Univ.),	Clinton.	
Leamy, Patrick Arthur (Boston Univ.),	Petersham.	
Marshall, James Laird (Boston Univ.),	South Lancaster.	
Moore, Henry Ward (Boston Univ.),	Worcester.	
Nutting, Charles Allen (Boston Univ.),	North Leominster.	
Pentecost, William Lewis (Boston Univ.),	Worcester.	
Poole, Erford Wilson (Boston Univ.),	North Dartmouth.	
Poole, Isaac Chester (Boston Univ.),	North Dartmouth.	
Read, Frederick Henry (Boston Univ.),	Wilbraham.	
Roper, Harry Howard (Boston Univ.),	East Hubbardston.	
Saito, Seijiro (Boston Univ.),	Nemuro, Japan.	
Sastré de Veraud, Salomé (Boston Univ.),	Tabasco, Mexico.	
Sellew, Merle Edgar (Boston Univ.),	East Longmeadow.	
Shaw, Frederic Bridgman (Boston Univ.),	South Amherst.	
Shepard, Lucius Jerry (Boston Univ.),	Oakdale.	
Shultis, Newton (Boston Univ.),	Medford.	
Tsuda, George (Boston Univ.),	Tok o, Japan.	
Dickinson, Asa Williams ('74) (Boston Univ.),	Jersey City, N. J.	
Lewis, Henry Waldo ('95) (Boston Univ.),	Rockland.	
Total,		31

Senior Class.

Allen, Harry Francis,	Northborough.
Allen, John William,	Northborough.
Armstrong, Herbert Julius,	Sunderland.
Barry, John Marshall,	Boston.
Bartlett, James Lowell,	Salisbury.
Cheney, Liberty Lyon,	Southbridge.
Clark, Lafayette Franklin,	West Brattleboro', Vt.
Drew, George Albert,	Westford.
Emrich, John Albert,	Amherst.
Goessmann, Charles Ignatius,	Amherst.
King, Charles Austin,*	East Taunton.

* Died at Amherst April 16, 1896, from pneumonia.

Leavens, George Davison,	Brooklyn Heights, N. Y.
Norton, Charles Ayer,	Lynn.
Palmer, Clayton Franklin,	Stockbridge.
Peters, Charles Adams,	Worcester.
Smith, Jr., Philip Henry,	South Hadley Falls.
Total,	16

Junior Class.

Adjemian, Avedis Garrabet,	Kharpoot, Turkey.
Baxter, Charles Newcomb,	Quincy.
Charmbury, Thomas Herbert,	Amherst.
Clark, Clifford Gay,	Sunderland.
Eaton, Julian Stiles,	Nyack, N. Y.
Fisher, Willis Sikes,	Ludlow.
Kinsman, Willard Quincy,	Ipswich.
Montgomery, Jr., Alexander,	Natick.
Nickerson, John Peter,	West Harwich.
Warden, Randall Duncan,	Roxbury.
Wiley, Samuel William,	Amherst.
Wright, George Henry,	Deerfield.
Total,	12

Sophomore Class.

Armstrong, William Henry,	Cambridge.
Beaman, Dan Ashley,	Leverett.
Boutelle, Albert Arthur,	Leominster.
Canto, Ysidro Herrera,	Cansahcat, Yucatan.
Chapin, William Edward,	Chicopee.
Chapman, John Chauncey,	Amherst.
Courtney, Howard Scholes,	Attleborough.
Dana, Herbert Warner,	South Amherst.
Davis, John Alden,	East Longmeadow.
Dickinson, Carl Clifton,	South Amherst.
Dutcher, John Remson,	Nyack, N. Y.
Hinds, Warren Elmer,	Townsend.
Holt, Henry Day,*	Amherst.
Hooker, William Anson,	Amherst.
Hubbard, George Caleb,	Sunderland.
Keenan, George Francis,	Boston.

* Killed by accidental discharge of gun at North Hadley, Aug. 5, 1896.

Maynard, Howard Eddy, . . .	Amherst.
Pingree, Melvin Herbert, . . .	Denmark, Me.
Sharpe, Edward Hewett, . . .	Northfield.
Smith, Bernard Howard, . . .	Middlefield.
Smith, Carl William, ...	Melrose.
Smith, Samuel Eldredge, . . .	Middlefield.
Stacy, Clifford Eli, ...	Gloucester.
Turner, Frederick Harvey, . .	Housatonic.
Walker, Charles Morehouse, . .	Amherst.
Wright, Edwin Monroe, . . .	Manteno, Ill.
Total, ...	26

Freshman Class.

Atkins, Edwin Kellogg, . . .	North Amherst.
Baker, Howard, ...	Dudley.
Crane, Henry Lewis, ...	Ellis.
Crowell, Jr., Charles Augustus, . .	Everett.
Crowell, Warner Rogers, . . .	Everett.
Frost, Arthur Forrester, . . .	South Monmouth, Me.
Gile, Alfred Dewing, . . .	Worcester.
Halligan, James Edward, . . .	Roslindale.
Harmon, Arthur Atwell, . . .	Chelmsford.
Hull, Edward Taylor, . . .	Greenfield Hill, Conn.
Hunting, Nathan Justus, . . .	Shutesbury.
Kellogg, James William, . . .	Amherst.
Landers, Morris Bernard, . . .	Bondsville.
Lewis, James, ...	Fairhaven.
March, Allen Lucas, ...	Ashfield.
Monahan, Arthur Coleman, . .	South Framingham.
Morrill, Austin Winfield, . . .	Tewksbury.
Munson, Mark Hayes, . . .	Huntington.
Ovalle Barros, Julio Moises, . .	Santiago, Chile.
Parmenter, George Freeman, . .	Dover.
Risley, Clayton Erastus, . . .	Plainfield, N. J.
Rogers, William Berry, . . .	Cambridge.
Saunders, Edward Boyle, . . .	Southwick.
Stanley, Francis Guy, . . .	Springfield.
Thompson, George Harris Austin, .	Lancaster.
Walker, Henry Earl, ...	Vineyard Haven.
West, Albert Merril, . . .	Brookville.
Total, ...	27

Graduates' Two-Years Course.

Alexander, Leon Rutherford,	East Northfield.	
Barrett, Frederick Eugene,	Framingham.	
Capen, Elwyn Winslow,	Stoughton.	
Coleman, Robert Parker,	West Pittsfield.	
Davis, John Alden,	East Longmeadow.	
Dickinson, Harry Porter,	Sunderland.	
Lincoln, Leon Emory,	Taunton.	
Total,		7

Second Year.

Ashley, Henry Simeon,	East Longmeadow.	
Burrington, John Cecil,	Charlemont.	
Colburn, Charles Day,	Westford.	
Dye, Willie Arius,	Sheffield.	
Humphrey, Charles Leonard,	Amherst.	
Merriman, Francis Evander,	Boston.	
Pendleton, Charles Bemis,	Willimansett.	
Perry, Edward King,	Brookline.	
Sastré de Veraud, César,	Tabasco, Mexico.	
Total,		9

Graduate Course.

For Degree of M.S.

Burgess, Albert Franklin,	Rockland.	
Kinney, Asa Stephen,	Worcester.	
Total,		2

Resident Graduates at the College and Experiment Station.

Crocker, B.Sc., Charles Stoughton (Boston Univ.),	Sunderland.
Hammar, B.Sc., James Fabens (Boston Univ.),	Swampscott.
Haskins, B.Sc., Henri Darwin (Boston Univ.),	North Amherst.

Holland, B.Sc., Edward Bertram (Boston Univ.),	Amherst.
Putnam, B.Sc., Joseph Harry (Boston Univ.),	West Sutton.
Smith, B.Sc., Robert Hyde (Boston Univ.),	Amherst.
Thomson, B.Sc., Henry Martin (Boston Univ.),	Monterey.
Todd, Frederick Gage,	Dorchester.
White, B.Sc., Edward Albert (Boston Univ.),	Ashby.
Total,	9

Special Student.

Cross, Edward Winslow,	Manchester, N. H.
Total,	1

Summary.

Graduate course: —		
For degree of M.S.,	2	
Four-years course: —		
Graduates of 1896,	31	
Senior class,	16	
Junior class,	12	
Sophomore class,	26	
Freshman class,	27	
Two-years course: —		
Graduates of 1896,	7	
Second year,	9	
Resident graduates,	9	
Special student,	1	
Total,		140
Entered twice,		2
Total,		138

FOUR-YEARS COURSE OF STUDY.

Freshman Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, . .	- - -	Botany, structural, — 5.	- - -	- - -	Advanced algebra, — 5. Book-keeping, — 2.	English, — 2.	French, — 4.	Study of tactics, — 1.
Winter, .	History of agriculture, soils and soil formation, — 4.	- - -	- - -	- - -	Advanced algebra and geometry (plane), — 4.	English, — 2.	French, — 4	Mechanical drawing, — 6.
Summer, .	Soils: — characteristics, improvement of, drainage, etc., — 4.	Botany, analytical, — 4.	Lectures in elementary chemistry, — 3.	- - -	Geometry (solid), — 3.	English, — 2.	French, — 3.	- -

Sophomore Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, . .	Irrigation, disposition of sewage, manures and fertilizers, — 4.	Botany, economic, and laboratory work, — 4.	Lectures in elementary chemistry, — 4.	- - -	Trigonometry, — 3.	English, — 2.	- -	- -
Winter, .	- - -	Laboratory work, — 4.	Lectures and practice, — 4.	Anatomy and physiology, — 4.	Surveying, — 3.	English, — 2.	- -	Mechanical drawing, — 4.
Summer, .	Relations of the atmosphere to plant-life, mowings, pastures, grasses, ensilage, — 5.	Horticulture, — 5.	Dry and humid qualitative analysis, — 3.	- - -	Surveying, — 4.	English, — 2.	- -	- -

Junior Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Zoölogy.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, . .	Field crops, seed raising, production and improvement of varieties, machines and implements, — 4.	Market gardening, — 3.	Qualitative analysis, — 5.	Zoölogy, laboratory work, — 8.	Physics, — 2.	Rhetoric and composition, — 4.	- -	- -
Winter, .	Breeds and breeding of live stock, poultry farming, — 2.	- - -	Lectures and practice in organic chemistry, — 6.	Zoölogy, — 3.	Physics, — 3.	- -	English literature, — 4.	Course in laboratory physics, — 4.
Summer, .	- - -	Landscape gardening, — 5.	The same continued, — 5.	Entomology, — 6.	Physics, — 4.	English, — 2.	- -	- -

Senior Year (Elective).*

	Agriculture.	Botany and Horticulture.	Chemistry.	Zoölogy.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, . .	Dairy farming, — 5.	Botany, cryptogamic, — 8.	Chemical physics and quantitative analysis, — 8.	Entomology, — 8. Veterinary science, — 5.	Engineering, — 5. Analytical geometry, — 5.	English, — 2. Advanced English, — 5. Latin, — 5.	Political economy, — 5. German, — 5. History, — 5.	Military science, — 1.
Winter, .	Cattle feeding, — 5.	Botany, cryptogamic, — 8.	Advanced work with lectures, — 8.	Entomology, — 8. Veterinary science, — 5.	Engineering, — 5. Differential calculus, — 5.	English, — 2. Advanced English, — 5. Latin, — 5.	Political economy, — 5. German, — 5. History, — 5.	Military science, — 1. Law lectures, — 1.
Summer, .	Experimental work in agriculture, — 5.	Botany, physiological, — 8.	The same continued, — 8.	Entomology, — 8. Veterinary science, — 5.	Engineering, — 5. Integral calculus, — 5.	English, — 2. Advanced English, — 5. Latin, — 5.	Constitutional history, — 5. German, — 5. History, — 5.	Military science, — 1.

* English and military science are required; of the other studies three at least must be chosen.

SHORT WINTER COURSES.

[All courses optional.]

Agriculture.

I. General Agriculture.

1.	Soils and operations upon them, drainage, irrigation, etc.,	10
2.	Farm implements and machinery,	5
3.	Manures and fertilizers,	10
4.	Crops of the farm, characteristics, management, etc.,	10
5.	Crop rotation,	2
6.	Farm book-keeping,	5
7.	Agricultural economics,	11
8.	Farm, dairy and poultry management,	11
	Total hours,	64

II. Animal Husbandry.

1.	Introduction,	1
2.	Location and soil,	2
3.	Building,	4
4.	Breeds of cattle,*	10
5.	Breeds of horses,	6
6.	Grain and fodder crops,*	11
7.	Foods and feeding,*	11
8.	Extra,	19
	Total hours,	64

* With dairy course.

Dairying.

III. Lectures and Class-room Work.

1.	The soil and crops,	22
2.	The dairy breeds and cattle breeding,	22
3.	Stable construction and sanitation, care of cattle,	11
4.	Common diseases of stock, their prevention and treatment,	11
5.	Foods and feeding,	11
6.	Book-keeping for the dairy farm and butter factory,	22
7.	Pasteurization and preparation of milk on physicians' prescriptions,	11
8.	Composition and physical peculiarities of milk; conditions which affect creaming, churning, methods of testing and preservation,	22
9.	Milk testing,	6
10.	Butter making,	12
11.	Practice in aeration, pasteurization,	6
	Total hours,	156

Horticulture.

IV. Fruit Culture.

1.	Introduction,	1
2.	Propagation of fruit trees by seed, budding, grafting, forming the head, digging, planting, pruning, training, cultivation, etc.,	28
3.	Insects and fungous diseases,	3
	Total hours,	32

V. Floriculture.

1.	Greenhouse construction and heating,	6
2.	Propagation of greenhouse and other plants by seed, cuttings, grafting, etc.,	3
3.	Cultivation of rose, carnation, chrysanthemum and orchids,	12
4.	Propagation and care of greenhouse and bedding plants,	10
5.	Insects and fungi which attack greenhouse plants,	2
	Total hours,	33

VI. Market Gardening.

1.	Introduction, equipment, tools, manures, fertilizers, etc.,	3
2.	Greenhouse construction and heating,	6
3.	Forcing vegetables under glass,	3
4.	Seed growing by the market gardener,	3
5.	Special treatment required by each crop,	10
6.	Insects and fungi, with remedies,	2
	Total hours,	27

BOTANY.

VII. Lectures on Injurious Fungi of the Farm, Garden, Greenhouse, Orchard and Vineyard.

1.	Introduction,	2
2.	Nature and structure of rusts,	4
3.	Nature and structure of smuts,	4
4.	Nature and structure of mildews,	4
5.	Nature and structure of rots,	4
6.	Beneficial fungi of roots,	2
7.	Edible mushrooms,	2
	Total hours,	22

VIII. Lectures and Demonstrations on "How Plants Grow."

1.	Introduction,	1
2.	The parts of a plant,	1
3.	Structure of the cell and plant in general,	3
4.	Functions of root, stem and leaves,	3
5.	Food of plant obtained from air,	3
6.	Food of plant obtained from soil,	3
7.	Transference and elaboration of food,	2
8.	Growth of plants,	2
9.	Effects of light, moisture, heat and cold,	2
10.	Root tubercles on pea and clover,	1
11.	Cross fertilization of flowers,	1
	Total hours,	22

CHEMISTRY.

IX. General Agricultural Chemistry.

1.	Introduction,	2
2.	The fourteen elements of agricultural chemistry,	1
3.	Rocks and soils,	8
4.	The atmosphere,	7
5.	The chemistry of crop-growing,	8
6.	Fertilizers,	8
7.	Animal chemistry,	8
	Total hours,	55

X. Chemistry of the Dairy.

1.	Introduction,	2
2.	The fourteen elements of agricultural chemistry,	14
3.	The physical properties of milk,	13
4.	Analysis of milk, butter, cheese and other dairy products,	13
5.	Chemistry of the manufacture of dairy products,	13
	Total hours,	55

ZOÖLOGY.

XI. Animal Life on the Farm.

Total hours, 22

XII. Insect Friends and Foes of the Farmers.

Total hours, 33

GRADUATE COURSE.

1. Honorary degrees will not be conferred.

2. Applicants will not be eligible to the degree of M.S. until they have received the degree of B.Sc. or its equivalent.

3. The faculty shall offer a course of study in each of the following subjects: mathematics and physics; chemistry; agriculture; botany; horticulture; entomology; veterinary. Upon the satisfactory completion of any two of these the applicant shall receive the degree of M.S. This prescribed work may be done at the Massachusetts Agricultural College or at any institution which the applicant may choose; but in either case the degree shall be conferred only after the applicant has passed an examination at the college under such rules and regulations as may be prescribed.

4. Every student in the graduate course shall pay twenty-five dollars to the treasurer of the college before receiving the degree of M.S.

TEXT-BOOKS.

GRAY — "Manual." American Book Company, New York.

DARWIN and ACTON — "Practical Physiology of Plants." University Press, Cambridge.

STRAUSSBERGER — "Practical Botany." Swan, Sonnenschein & Co., London.

SORAUER — "Physiology of Plants." Longmans, Green & Co., New York and London.

GREINER — "How to make the Garden pay." Wm. Maule, Philadelphia.

LONG — "Ornamental Gardening for Americans." Orange Judd Company, New York

TAFT — "Greenhouse Construction" Orange Judd Company, New York.

WEED — "Insects and Insecticides." Orange Judd Company, New York.

WEED — "Fungi and Fungicides." Orange Judd Company, New York.

FULLER — "Practical Forestry." Orange Judd Company, New York.

MAYNARD — "Practical Fruit Grower" Orange Judd Company, New York.

MCALPINE — "How to know Grasses by their Leaves" David Douglas, Edinburgh.

LODEMAN — "The Spraying of Crops." Macmillan & Co, New York

SAUNDERS — "Insects injurious to Fruits." Lippincott & Co., Philadelphia.

AIKMAN — "Manures and Manuring." Blackwood & Sons, London.
ARMSBY — "Manual of Cattle Feeding." Wiley & Sons, New York.
MILES — "Stock Breeding" D. Appleton & Co, New York.
CURTIS — "Horses, Cattle, Sheep and Swine." Orange Judd Company, New York.
SHEPARD — "Elementary Chemistry." D. C. Heath & Co., Boston.
STORER — "Agriculture in Some of its Relations to Chemistry." Chas. Scribner's Sons, New York.
RICHTER and SMITH — "Text-book of Inorganic Chemistry." P. Blackiston Son & Co., Philadelphia.
MÜTER — "Analytical Chemistry." P. Blackiston Son & Co., Philadelphia.
ROSCOE — "Lessons in Elementary Chemistry." Macmillan & Co., New York.
BERNTHSEN and McGOWAN — "Text-book of Organic Chemistry" Blackie & Son, London.
REYNOLDS — "Experimental Chemistry." Longmans, Green & Co., New York and London.
SUTTON — "Volumetric Analysis." J. & A. Churchill, London.
DANA — "Manual of Determinative Mineralogy." John Wiley & Sons, New York.
THOMSON — "Commercial Arithmetic." Maynard, Merrill & Co., New York.
MESERVEY — "Single and Double Entry Book-keeping." Thompson, Brown & Co., Boston.
WELLS — "College Algebra." Leach, Shewell & Sanborn, Boston.
WELLS — "Plane and Solid Geometry." Leach, Shewell & Sanborn, Boston.
WELLS — "Essentials of Trigonometry." Leach, Shewell & Sanborn, Boston.
BOWSER — "Analytic Geometry" D. Van Nostrand Company, New York.
OSBORNE — "Differential and Integral Calculus." Leach, Shewell & Sanborn, Boston.
GAGE — "Principles of Physics." Ginn & Co., Boston.
DAVIS — "Elementary Meteorology." Ginn & Co., Boston.
MERRIMAN and BROOKS — "Handbook for Surveyors." John Wiley & Sons, New York.
JOHNSON — "Theory and Practice of Surveying." John Wiley & Sons, New York.
BYRNE — "Highway Construction." John Wiley & Sons, New York.
SEARLES — "Field Engineering" John Wiley & Sons, New York.
FAUNCE — "Mechanical Drawing." W. J. Schofield, Boston.
FAUNCE — "Descriptive Geometry." Ginn & Co., Boston.
MARTIN — "Human Body" (briefer course). Henry Holt & Co., New York.
WALKER — "Political Economy" (abridged edition). Henry Holt & Co., New York.
WALKER — "Political Economy" (elementary course). Henry Holt & Co., New York.

LOCKWOOD — "Lessons in English." Ginn & Co., Boston.
GENUNG — "Outlines of Rhetoric." Ginn & Co , Boston.
SPRAGUE — "Six Selections from Irving's Sketch-book." Ginn & Co., Boston.
WENTWORTH — "Irving's Sketch Book." Allyn & Bacon.
LONGFELLOW — "Poems." Houghton, Mifflin & Co., Boston.
PATTEE — "American Literature." Silver, Burdett & Co., Boston.
PAINTER — "English Literature." Leach, Shewell & Sanborn, Boston.
PANCOAST — "Representative English Literature." Henry Holt & Co , New York.
JEVONS — "Logic." Science Primer Series. American Book Company, New York.
WHITNEY — "French Grammar." Henry Holt & Co., New York.
WHITNEY — "German Grammar." Henry Holt & Co., New York.
SHELDON — "Short German Grammar." D. C. Heath & Co., Boston.
HODGES — "Scientific German." D. C. Heath & Co., Boston.
U. S. ARMY — "Infantry Drill Regulations."
U. S. ARMY — "Artillery Drill Regulations."

To give not only a practical but a liberal education is the aim in each department, and the several courses have been so arranged as to best subserve that end. Weekly exercises in composition and declamation are held throughout the course. The instruction in agriculture and horticulture is both theoretical and practical, the lessons of the recitation room being practically enforced in the garden and field. Students are allowed to work for wages during such leisure hours as are at their disposal. Under the act by which the college was founded, instruction in military tactics is imperative, and each student, unless physically debarred,* is required to attend such exercises as are prescribed, under the direction of a regular army officer stationed at the college.

FOUR-YEARS COURSE.

ADMISSION.

Candidates for admission to the freshman class will be examined orally and in writing upon the following subjects: English grammar, geography, United States history, physiology, physical geography, arithmetic, the metric system, algebra (through quadratics), geometry (two books) and civil government (Mowry's "Studies in Civil Government"). The standard required is 65 per cent. on each paper. Diplomas from high schools will *not* be received in place of examination. Examination in the following subjects may be taken a year before the candidate expects

* Certificates of disability must be procured of Dr. Herbert B. Perry of Amherst.

to enter college: English grammar, geography, United States history, physical geography and physiology. Satisfactory examination in a substantial part of the subjects offered will be required, that the applicant may have credit for this preliminary examination.

Candidates for higher standing are examined as above, and also in the studies gone over by the class to which they desire admission.

No one can be admitted to the college until he is sixteen years of age. The regular examinations for admission are held at the Botanic Museum, at 9 o'clock A.M., on Thursday and Friday, June 24 and 25, and on Tuesday and Wednesday, September 7 and 8; but candidates may be examined and admitted at any other time in the year. For the accommodation of those living in the eastern part of the State, examinations will also be held at 9 o'clock A.M., on Thursday and Friday, June 24 and 25, at Jacob Sleeper Hall, Boston University, 12 Somerset Street, Boston; and for the accommodation of those in the western part of the State, at the same date and time, at the Sedgwick Institute, Great Barrington, by James Bird. Two full days are required for examination, and candidates must come prepared to stay that length of time.

WINTER COURSES.

For these short winter courses examinations are not required. They commence the first Wednesday in January and end the third Wednesday in March. Candidates must be at least sixteen years of age. The doors of the college are opened to applicants from both sexes. The same privileges in regard to room and board will obtain as with other students. Attendance upon general exercises is required. The usual fees for apparatus and material used in laboratory work will be required. Attendance upon military drill is not expected.

ENTRANCE EXAMINATION PAPERS USED IN 1896.

The standard required is 65 per cent. on each paper.

Arithmetic and Metric System.

1. What is the length of a pole that stands $\frac{2}{7}$ in the mud, $\frac{4}{9}$ in the water and 25.5 feet above the water?

2. Reduce to simplest form $\frac{4\frac{3}{4} + \frac{2}{3}}{3\frac{1}{7} - 1\frac{3}{14}} \times 2$.

3. A merchant, after paying 60% of his indebtedness, found that $3,500 would discharge the remainder. What was his whole indebtedness?

4. If a stationer marks his goods 50% above cost, and then abates 50%, what per cent. does he make or lose?

5. What will $864.50 amount to in 2 years at 8% compound interest, interest being compounded semi-annually?

6. What is the square root of 1,100,401?

7. In 387 cm., how many feet?

8. The circumference of a circular court is 48 m. 4 dm. How many km. should I walk in going 8 times around it?

9. A rectangular vessel 10 m. × 3 m. × 4 dm. will contain how many litres of water? What will be the weight of this water in grams?

Algebra.

1. Resolve into factors $3x^2+10x+3$.
Resolve into factors $6x^2-31x+35$.

2. A smuggler had a quantity of brandy which he expected would bring him $198. After he had sold 10 gallons a revenue officer seized one-third of the remainder, in consequence of which the smuggler gets only $162. Required, the number of gallons he had at first, and the price per gallon.

3. Simplify $\left(\frac{x+1}{x-1}\right)\left(\frac{x+2}{x^2-1}\right)\left(\frac{x-1}{(x+2)^2}\right)$.

4. Rationalize $\frac{\sqrt{1+x^2}-\sqrt{1-x^2}}{\sqrt{1+x^2}+\sqrt{1-x^2}}$.

5. Express with positive exponents and reduce to lowest terms $\left(\frac{a^{-2}b}{a^3b^{-4}}\right)^{-3} \div \left(\frac{ab^{-1}}{a^{-3}b^2}\right)$.

6. $\frac{x+\frac{1}{x}}{x-\frac{1}{x}}+\frac{1+\frac{1}{x}}{1-\frac{1}{x}}=3\tfrac{1}{4}$. Solve for x.

7. Find the square root of

$$\frac{6b}{a}+\frac{6a}{b}-7+\frac{a^3}{b^3}-\frac{3a^2}{b^2}-\frac{3b^2}{a^2}+\frac{b^3}{a^3}.$$

Geometry.

Prove the following propositions: —

1. Two triangles are equal when two sides and the included angle of one are equal to two sides and the included angle of the other.

2. If two parallels are cut by a secant line, the alternate interior angles are equal.

3. The diagonals of a parallelogram bisect each other.

4. The medians of a triangle meet in a common point.

5. In the same circle or equal circles, equal chords subtend equal arcs.

9. The diameter perpendicular to a chord bisects the chord and its subtended arcs.

United States History.

Note. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Write a short sketch of the life of George Washington.

2. Describe the surrender of Lord Cornwallis at Yorktown at the close of the Revolutionary War.

3. Tell what you can of the rise and fall of the slave power in the United States.

4. What were the "Articles of Confederation?"

5. Write a short sketch of the life of Abraham Lincoln.

6. Give the causes, dates and chief events of the war with Tripoli.

7. Give the events associated with the following dates: 1770, 1789, 1812, 1820, 1848, 1863, 1865, 1893.

8. Give the name of the most famous Confederate commerce destroyer of the Civil War. Tell by whom she was commanded, and relate the circumstances connected with her destruction.

9. Name the Presidents that have held office since the Civil War, giving the dates of each administration.

10. What do you know about the Venezuelan question?

Geography.

Note. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Describe the geographical features of New England, naming its mountains, lakes, rivers.

2. Describe the Rocky Mountain system.

3. (*a*) Trace the course of the Mississippi River.
   (*b*) Name the States bordering the east bank.

4. Give the capital of Vermont, Rhode Island, New York, Pennsylvania, Ohio, California, Oregon, Texas.

5. Draw a map of Italy and locate Rome, Milan, Venice, Naples

6. Locate Tokyo, Tasmania, Yucatan, Bombay, Sydney.

7. Name the different kinds of government, and give two examples of each kind.

8. Define equator, zone, longitude, latitude, meridian.

9. Describe Alaska, telling of (*a*) its government, (*b*) its geographical features, (*c*) its products.

10. Describe fully the West Indies, telling (*a*) the names of the several islands, (*b*) the class of people, (*c*) the products.

Physical Geography.

Note — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. What is the difference between physical and political geography?

2. What is a river system, a watershed, an alluvial plain, a delta?

3. What is an ocean current? Give causes of ocean currents.

4. What causes the winds to blow? Define a trade wind, a monsoon and a hurricane.

5. Give a definition of climate. Name three distinct causes thereof.

6. What is a compass? Does the compass always point north? What is the magnetic pole? Is it the same as the north pole?

7. What is a geyser? Where are some of the finest geysers found?

8. Define a glacier, a lateral moraine, a terminal moraine. Where are glaciers found? Name the countries.

9. Describe the formation of a coral island, with its plant and animal life.

10. Of what practical value is the study of physical geography?

Civil Government.

Note. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. What is meant by *civil government?* How does it differ from *military government?*

2. By what name is the government of towns, cities or incorporated villages distinguished?

3. In whose hands is the government of a town? What is a *town meeting?* Mention *three* distinct purposes for which a town meeting is held.

4. If you live in a town, mention some of the duties of the selectmen of the town. If you live in a city, mention some of the duties of the mayor of your city.

5. Give the title of any *county* officer chosen by the people, and mention any of his duties. What is the title of the chief executive officer of the State of Massachusetts? What is his name?

6. Who make the laws for the government of the State in which you live? In what bodies is the law-making power vested? How often and where do the law-making bodies meet?

7. How many States are there in the United States? How many States were there when the Constitution was framed? When did the colonies become States?

8. Who make the laws for the government of the United States? How many men from the State of Massachusetts have part in making these laws? Who represents in the national House of Representatives the district in which you live?

9. What is the title of the chief executive officer of the United States? Is he elected directly by the people? Tell how he is elected.

10. What is the judicial power of the United States? In what is it vested?

Physiology.

Note. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Define a tissue, an organ, a function.

2. Of what is the skeleton composed? Describe the backbone.

3. What is a muscle, and how are the muscles of the body classified?

4. Describe the skin. What are nails and hair? Give their uses.

5. What gives the color to a negro? Where is this color situated? What causes blushing or reddening of the skin in cold weather? Where is this color found?

6. What is a food? What is a poison? Under which head would you class alcohol? Why?

7. Describe the teeth, giving their number and location in the mouth. Give some rules concerning the hygiene of the teeth.

8. Describe in detail the course of the blood throughout the body; name the most important portion of the circulatory system.

9. Give some rules for physical and mental exercise, and tell what would constitute a well-developed man.

10. Name *six* special senses in order of their importance, and name and briefly describe the organ connected with each.

English Grammar and Composition.

Note. — Penmanship, spelling, capitalization and punctuation will be considered in determining the excellence of your paper.

1. Name the parts of speech, define each, and give examples of each.

2. Define (*a*) clause, (*b*) phrase, (*c*) participle, (*d*) infinitive.

3. Give examples of the three kinds of sentences as classified by grammar, naming each kind.

4. Correct the following, stating reasons: —

(*a*) The box of figs were sent to the woman.

(*b*) A room to let for a man fifteen by twenty feet.

(*c*) John ran to see the team in the yard which was being painted.

(*d*) Oh, isn't it a perfectly sublime morning! And I am just dead hungry. Do hurry up and come to breakfast, for we have cherries and I just adore them.

(*e*) Mr. Gray's election was more unanimous than Mr. Brown's.

5. Explain the use of (*a*) the interrogation point, (*b*) the exclamation point, (*c*) the comma, (*d*) the period, (*e*) the quotation marks.

6–8. Describe the town in which you live. Make the account interesting, and write as carefully as possible.

9–10. Write short accounts of the following men. Mention in your accounts some of the works these authors have composed.

(*a*) Washington Irving.

(*b*) Henry W. Longfellow.

(*c*) John Greenleaf Whittier.

(*d*) Nathaniel Hawthorne.

DEGREES.

Those who complete the four-years course receive the degree of Bachelor of Science, the diploma being signed by the governor of Massachusetts, who is the president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and upon graduation receive its diploma in addition to that of the college, thereby becoming entitled to all the privileges of its alumni.

Those completing the graduate course receive the degree of Master of Science.

EXPENSES.

Tuition in advance: —			
Fall term,	$30 00		
Winter term,	25 00		
Summer term,	25 00		
		$80 00	$80 00
Room rent, in advance, $8 to $16 per term,		24 00	48 00
Board, $2 50 to $5 per week,		95 00	190 00
Fuel, $5 to $15,		5 00	15 00
Washing, 30 to 60 cents per week,		11 40	22 80
Military suit,		15 75	15 75
Expenses per year,		$231 15	$371 55

Board in clubs has been about $2.45 per week; in private families, $4 to $5. The military suit must be obtained immediately upon entrance at college, and used in the drill exercises prescribed. The following fees will be charged for the maintenance of the several laboratories: chemical, $10 per term used; zo logical, $4 per term used; botanical, $1 per term used by sophomore class, $2 per term used by senior class; entomological, $2 per term used. Some expense will also be incurred for lights and text-books. Students whose homes are within the State of Massachusetts can in most cases obtain a scholarship by applying to the senator of the district in which they live.

THE LABOR FUND.

The object of this fund is to assist those students who are dependent either wholly or in part on their own exertions, by furnishing them work in the several departments of the college. The greatest opportunity for such work is found in the agricultural and horticultural departments. Application should be made to Profs. William P. Brooks and Samuel T. Maynard, respectively in charge of said departments. Students desiring to avail themselves of its benefits must bring a certificate signed by one of the selectmen of the town in which they are resident, certifying to the fact that they require aid.

ROOMS.

All students, except those living with parents or guardians, will be required to occupy rooms in the college dormitories.

For the information of those desiring to carpet their rooms, the following measurements are given: in the new south dormitory the study rooms are about fifteen by fourteen feet, with a recess seven feet four inches by three feet; and the bedrooms are eleven feet two inches by eight feet five inches. This building is heated by steam. In the north dormitory the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet. The inside rooms are thirteen and one-half by fourteen and one-half feet, and the bedrooms eight by eight feet. A coal stove is furnished with each room. Aside from this, all rooms are unfurnished. Mr. Thomas Canavan has the general superintendence of the dormitories, and all correspondence relative to the engaging of rooms should be with him.

SCHOLARSHIPS.

Established by Private Individuals.

Mary Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield.

Whiting Street Fund of one thousand dollars, the bequest of Whiting Street, Esq., of Northampton.

Henry Gassett Fund of one thousand dollars, the bequest of Henry Gassett, Esq., of North Weymouth.

The income of the above funds is assigned by the faculty to worthy students requiring aid.

CONGRESSIONAL SCHOLARSHIPS.

The trustees voted in January, 1878, to establish one free scholarship for each of the congressional districts of the State. Application for such scholarships should be made to the representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Applicants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course.

STATE SCHOLARSHIPS.

The Legislature of 1883 passed the following resolve in favor of the Massachusetts Agricultural College: —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide for the students of said institution the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually, for the term of four years, eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place as the senator then in office from each district shall designate; and the said scholarships shall be assigned equally to each senatorial district. But, if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible; but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as hereinbefore provided.

The Legislature of 1886 passed the following resolve, making perpetual the scholarships established: —

Resolved, That annually the scholarships established by chapter forty-six of the resolves of the year eighteen hundred and eighty-three be given and continued in accordance with the provisions of said chapter.

In accordance with these resolves, any one desiring admission to the college can apply to the senator of his district for a scholarship. Blank forms of application will be furnished by the president.

EQUIPMENT.

Agricultural Department.

The Farm. — Among the various means through which instruction in agriculture is given, none exceeds in importance the farm. The part which is directly under the charge of the professor of agriculture comprises about one hundred and fifty acres of improved land and thirty acres of woodland. Of the improved

land, about thirty acres are kept permanently in grass. A considerable part of this is laid off in half and quarter acre plats, and variously fertilized with farm-yard and stable manures and chemicals, with a view to throwing light upon the economical production of grass. These plats are staked and labelled, so that all may see exactly what is being used and what are the results.

The rest of the farm is managed under a system of rotation, all parts being alternately in grass and hoed crops. All the ordinary crops of this section are grown, and many not usually seen upon Massachusetts farms find a place here. Our large stock of milch cows being fed almost entirely in the barn, fodder crops occupy a prominent place. Experiments of various kinds are continually under trial; and every plat is staked, and bears a label stating variety under cultivation, date of planting, and manures and fertilizers used.

Methods of land improvement are constantly illustrated here, tile drainage especially receiving a large share of attention. There are now some nine miles of tile drains in successful and very satisfactory operation upon the farm. Methods of clearing land of stumps are also illustrated, a large amount of such work having been carried on during the last few years.

In all the work of the farm the students are freely employed, and classes are frequently taken into the fields; and to the lessons to be derived from these fields the students are constantly referred.

The Barn and Stock. — Our commodious barns contain a large stock of milch cows, many of which are grades; but the following pure breeds are represented by good animals, viz., Holstein-Friesian, Ayrshire, Jersey, Guernsey and Shorthorn. Experiments in feeding for milk and butter are continually in progress. We have a fine flock of Southdown sheep and a few choice specimens of the Shropshire, Horned Dorset, Cotswold and Merino breeds. Swine are represented by the Chester White, Poland China, Middle Yorkshire and Tamworth breeds. Besides work horses, we have a number of pure-bred Percherons, used for breeding as well as for work.

The barn is a model of convenience and labor-saving arrangements. It illustrates different methods of fastening animals, various styles of mangers, watering devices, etc. Connected with it are a plant for electric light and power and commodious storage rooms for vehicles and machines. It contains silos and a granary. A very large share of the work is performed by students, and whenever points require illustration, classes are taken to it for that purpose.

Dairy School. — Connecting with the barn is a wing providing accommodation for practical and educational work in dairying. The wing contains one room for heavy dairy machinery, another for lighter machinery, both large enough to accommodate various styles of all prominent machines; a large ice house, a cold-storage room and a room for raising cream by gravity methods, a class room and a laboratory. The power used is an electric motor. This department is steam heated and piped for hot and cold water and steam. In this department has been placed a full line of modern dairy machinery, so that we are able to illustrate all the various processes connected with the creaming of milk, its preparation for market and the manufacture of butter. Special instruction in such work is offered in the dairy course.

Equipment of Farm. — Aside from machines and implements generally found upon farms, the more important of those used upon our farm and in our barn which it seems desirable to mention are the following: reversible sulky plough, broadcast fertilizer distributer, manure spreader, grain drill, horse corn planter, potato planter, wheelbarrow grass seeder, hay loader, potato digger, hay press, fodder cutter and crusher and grain mill. It is our aim to try all novelties as they come out, and to illustrate everywhere the latest and best methods of doing farm work.

Lecture Room. — The agricultural lecture room in south college is well adapted to its uses. It is provided with numerous charts and lantern slides, illustrating the subjects taught. Connected with it are two small rooms at present used for the storage of illustrative material, which comprises soils in great variety, all important fertilizers and fertilizer materials, implements used in the agriculture of our own and other countries, and a collection of grasses and forage plants, grains, etc.

A valuable addition to our resources consists of a full series of Landsberg's models of animals. These are accurate models of selected animals of all the leading breeds of cattle, horses, sheep and swine, from one-sixth to full size, according to subject. We are provided with a complete collection of seeds of all our common grasses and the weeds which grow in mowings, and have also a large collection of the concentrated food stuffs. All these are continually used in illustration of subjects studied.

Museum. — An important beginning has been made towards accumulating materials for an agricultural museum. This is to contain the rocks from which soils have been derived, soils, fertilizer materials and manufactured fertilizers, seeds, plants and their products, stuffed animals, machines and implements. It is

expected to make this collection of historical importance by including in it old types of machines and implements, earlier forms of breeds, etc. For lack of room the material thus far accumulated is stored in a number of scattered localities, and much of it where it cannot be satisfactorily exhibited.

Botanical Department.

Course of Study. — This department is well equipped to give a comprehensive course in most of the subjects of botany. The course aims to treat of all the more important features connected with the study of plants which have a close bearing upon agriculture, without at the same time deviating from a systematic and logical plan. Throughout the entire course the objective methods of teaching are followed, and the student is constantly furnished with an abundance of plant material for practical study, together with an elaborate series of preserved specimens for illustration and comparison. In the freshman year the study of structural and systematic botany is pursued, with some observation on insect fertilization. This is followed in the first term of the sophomore year by the systematic study of grasses, trees and shrubs, and this during the winter term by an investigation into the microscopic structure of the plant. The senior year is given up entirely to cryptogamic and physiological botany.

The Botanical Museum contains the Knowlton herbarium, of over ten thousand species of phanerogamous and the higher cryptogamous plants; about five thousand species of fungi, and several collections of lichens and mosses, including those of Tuckerman, Frost, Denslow, Cummings, Müller and Schaerer. It also contains a large collection of native woods, cut so as to show their individual structure; numerous models of native fruits; specimens of abnormal and peculiar forms of stems, fruits, vegetables, etc.; many interesting specimens of unnatural growths of trees and plants, natural grafts, etc.; together with models for illustrating the growth and structure of plants, and including a model of the squash which raised by the expansive force of its growing cells the enormous weight of five thousand pounds.

The Botanical Lecture Room, in the same building, is provided with diagrams and charts of over three thousand figures, illustrating structural, systematic and physiological botany.

The Botanical Laboratory, with provision for sixteen students to work at one time, is equipped with Leitz', Reichert's, Bausch and Lomb's, Beck's, Queen's and Tolles' compound microscopes,

with objectives varying from four inch to one-fifteenth inch focal length. It also contains a Du Bois-Reymond induction apparatus and rheocord, a Lippmann capillary electrometer, a Thoma, a Minot and a Beck microtome, a self-registering thermometer and hygrometer, a Wortmann improved clinostat and also one of special construction, an Arthur centrifugal apparatus with electric motor, a Pfeffer-Baranetzky electrical self-registering auxanometer, a Sach's arc-auxanometer, a horizontal reading microscope (Pfeffer model), various kinds of dynamometers of special construction, respiration appliances, mercurial sap and vacuum gauges, manometers, gas and exhaust chambers, a Bausch and Lomb microphotographic camera, a Clay landscape camera and dark closet fitted for work, besides various other appliances for work and demonstration in plant physiology.

Horticultural Department.

Greenhouses. — To aid in the instruction of botany, as well as that of floriculture and market gardening, the glass structures contain a large collection of plants of a botanical and economic value, as well as those grown for commercial purposes. They consist of a large octagon, forty by forty feet, with sides twelve feet high and a central portion over twenty feet high, for the growth of large specimens, like palms, tree ferns, the bamboo, banana, guava, olive, etc.; a lower octagon, forty by forty feet, for general greenhouse plants; a moist stove twenty-five feet square; a dry stove of the same dimensions; a rose room, twenty-five by twenty feet; a room for aquatic plants, twenty by twenty-five feet; a room for ferns, mosses and orchids, eighteen by thirty feet; a large propagating house, fifty by twenty-four feet, fitted up with benches sufficient in number to accommodate fifty students at work at one time; a vegetable house, forty-two by thirty-two feet; two propagating pits, eighteen by seventy-five feet, each divided into two sections for high and low temperatures, and piped for testing overhead and under-bench heating; a cold grapery, eighteen by twenty-five feet. To these glass structures are attached three workrooms, equipped with all kinds of tools for greenhouse work. In building these houses as many as possible of the principles of construction, heating, ventilating, etc., have been incorporated for the purposes of instruction.

Orchards. — These are extensive, and contain nearly all the valuable leading varieties, both old and new, of the large fruits, growing under various conditions of soil and exposure.

Small Fruits. — The small-fruit plantations contain a large number of varieties of each kind, especially the new and promising ones, which are compared with older sorts, in plots and in field culture. Methods of planting, pruning, training, cultivation, study of varieties, gathering, packing and shipping fruit, etc., are taught by field exercises, the students doing a large part of the work of the department.

Nursery. — This contains more than five thousand trees, shrubs and vines in various stages of growth, where the different methods of propagation by cuttings, layers, budding, grafting, pruning and training are practically taught to the students.

Garden. — All kinds of garden and farm-garden crops are grown in this department, furnishing ample illustration of the treatment of market-garden crops. The income from the sales of trees, plants, flowers, fruit and vegetables aids materially in the support of the department, and furnishes illustrations of the methods of business, with which all students are expected to become familiar.

Forestry. — Many kinds of trees suitable for forest planting are grown in the nursery, and plantations have been made upon the college grounds and upon private estates in the vicinity, affording good examples of this most important subject. A large forest grove is connected with this department, where the methods of pruning trees and the management and preservation of forests can be illustrated. In the museum and lecture-room are collections of native woods, showing their natural condition and peculiarities; and there have been lately added the prepared wood sections of R. B. Hough, mounted on cards for class-room illustration.

Ornamental trees, shrubs and flowering plants are grouped about the grounds in such a way as to afford as much instruction as possible in the art of landscape gardening. All these, as well as the varieties of large and small fruits, are marked with conspicuous labels, giving their common and Latin names, for the benefit of the students and the public.

Tool House. — A tool house, thirty by eighty feet, has been constructed, containing a general store-room for keeping small tools; a repair shop with forge, anvil and work-bench; and a carpenter shop equipped with a large Sloyd bench and full set of tools. Under one-half of this building is a cellar for storing fruit and vegetables. In the loft is a chamber, thirty by eighty feet, for keeping hot-bed sashes, shutters, mats, berry crates, baskets and other materials when not in use.

Connected with the stable is a cold-storage room, with an ice-chamber over it, for preserving fruit, while the main cellar underneath the stable is devoted to the keeping of vegetables.

All the low land south of the greenhouses has been thoroughly underdrained and put into condition for the production of any garden or small fruit crop.

Zoölogical Department.

Zoölogical Lecture Room. — The room in south college is well adapted for lecture and recitation purposes, and is supplied with a series of zoölogical charts prepared to order, also a set of Leuckart's charts, disarticulated skeletons and other apparatus for illustration.

Zoölogical Museum. — This is in immediate connection with the lecture room, and contains the Massachusetts State collection, which comprises a large number of mounted mammals and birds, together with a series of birds' nests and eggs, a collection of alcoholic specimens of fishes, reptiles and amphibians, and a collection of shells and other invertebrates.

There is also on exhibition in the museum a collection of skeletons of our domestic and other animals, and mounted specimens purchased from Prof. H. A. Ward; a series of glass models of jelly fishes, worms, etc., made by Leopold Blaschka in Dresden; a valuable collection of corals and sponges from Nassau, N. P., collected and presented by Prof. H. T. Fernald; a fine collection of corals, presented by the Museum of Comparative Zoölogy in Cambridge; a collection of alcoholic specimens of invertebrates from the coast of New England, presented by the National Museum at Washington; a large and rapidly growing collection of insects of all orders; and a large series of clastic models of various animals, manufactured in the Auzoux laboratory in Paris.

It is the purpose of those in charge to render the museum as valuable to the student as possible; and with this end in view the entire collection has been rearranged so as to present a systematic view of the entire animal kingdom, with special regard to the fauna of Massachusetts. In the furtherance of this idea a special case has been prepared, in which are shown typical animals in such a way as to give a brief synopsis of the entire animal kingdom, forming a sort of index to the museum as a whole. In order to render our collection complete, particularly with refer-

ence to Massachusetts forms, we would gratefully receive donations of any sort, either alcoholic or otherwise preserved, especially among the worms, fishes, amphibians or reptiles. Specimens should be sent care of Prof. R. S. Lull. The museum is now open to the public from three to four P.M. every day except Sunday.

Zoölogical Laboratory. — A large room in the laboratory building has been fitted up for a zoölogical laboratory, with tables, sink, gas, etc., and is supplied with a reference library, microscopes, chemical and other necessary apparatus for work. This laboratory with its equipment is undoubtedly the most valuable appliance for instruction in the department of zoölogy.

Entomological Laboratory. — The new entomological laboratory adjoining the insectary, with its complete equipment, furnishes most excellent opportunities to study practical and scientific entomology. This building comprises a laboratory which occupies the whole northern and eastern portion of the first floor, which is well supported by piers and bridging to prevent, as far as possible, any jar that would interfere with the microscopical or other delicate work that may be going on. The room is equipped with all the apparatus necessary for the needs of the student, and he also has access to the insectary, where he can study the biological collection of insects and also observe the experimental work and investigations made on injurious insects. The library of the insectary, which is accessible to the students, contains all the leading works on entomology and also a very complete card catalogue of the literature of North American insects.

The second floor of the laboratory contains a photographing room with a dark room adjoining, private laboratories for graduate or undergraduate students who may be doing special work, while the attic furnishes ample store room. The entire building, including the insectary and greenhouse, is heated with a hot-water system and supplied with electric lights.

Veterinary Department.

This department is well equipped with the apparatus necessary to illustrate the subject in the class room.

It consists of an improved Auzoux model of the horse, imported from Paris, constructed so as to separate and show in detail the shape, size, structure and relations of the different parts of the body; two *papier-maché* models of the hind legs of the horse,

showing diseases of the soft tissues, — wind-galls, bogs, spavins, etc., also the diseases of the bone tissues, — splints, spavins and ringbones ; two models of the foot, one according to Bracy Clark's description, the other showing the Charlier method of shoeing and the general anatomy of the foot; a full-sized model of the bones of the hind leg, giving shape, size and position of each individual bone; thirty-one full-sized models of the jaws and teeth of the horse and fourteen of the ox, showing the changes which take place in these organs as the animals advance in age.

There is an articulated skeleton of the famous stallion, Blackhawk, a disarticulated one of a thoroughbred mare, besides one each of the cow, sheep, pig and dog; two prepared dissections of the fore and hind legs of the horse, showing position and relation of the soft tissues to the bones; a *papier-maché* model of the uterus of the mare and of the pig; a gravid uterus of the cow; a wax model of the uterus, placenta and fœtus of the sheep, showing the position of the fœtus and the attachment of the placenta to the walls of the uterus.

In addition to the above there is a growing collection of pathological specimens of both the soft and osseus tissues, and many parasites common to the domestic animals. A collection of charts and diagrams especially prepared for the college is used in connection with lectures upon the subject of anatomy, parturition and conformation of animals.

Through the kindness of Mr. Henry Adams of Amherst the department has received a large sample collection of the various drugs used in the treatment of the diseases of the domestic animals.

For the benefit of the students, sick or diseased animals are frequently shown them, and operations performed in connection with the class-room work. For the use of the instructor of this department a laboratory has been provided in the old chapel building. It has been equipped with the apparatus necessary for the study of histology, pathology and bacteriology, consisting in part of an improved Zeiss microscope with a one-eighteenth inch objective, together with the lower powers; a Lautenschlager's incubator and hot-air sterilizer; an Arnold's steam sterilizer and a Bausch and Lomb improved laboratory microtome. This apparatus is used for the preparation of material for the class room and for general investigation.

Mathematical Department.

At first glance it might appear that mathematics would play a very small part in the curriculum of an agricultural college, and, while it is true that its chief object is of a supplementary nature, it is equally true that, entirely aside from its value as a means of mental discipline, mathematics has a well-defined and practical object to accomplish. In this day of scientific experiment, observation and research on the farm, the advantages of a thorough knowledge of the more elementary branches of mathematics, general physics and engineering must be more than ever apparent; and it is to meet the needs of the agricultural college student in these lines that the work in the mathematical department has been planned.

The mathematics of the freshman, sophomore and junior years are required, those of the senior year elective.

A glance at the schedule of studies will show the sequence of subjects: book-keeping, algebra, geometry and mechanical drawing in the freshman year; trigonometry, mechanical drawing and plane surveying — the latter embracing lectures and field work in elementary engineering, the use of instruments, computation of areas, levelling, etc. — in the sophomore year; general physics — including mechanics, electricity, sound, light and heat — and descriptive geometry or advanced mechanical drawing in the junior year; and, finally, two electives in the senior year, — mathematics and engineering respectively.*

The mathematical option includes the following subjects: fall term, plane analytic geometry, embracing a study of the equations and properties of the point, line and circle, and of the parabola, ellipse and hyperbola; winter term, differential calculus; and summer term, integral calculus.

The senior engineering option is designed to give to the student the necessary engineering training to enable him to take up and apply, on the lines of landscape engineering and the development of property, his knowledge of landscape gardening, agriculture, forestry, botany and horticulture. It embraces a course of lectures, recitations and field work on the following subjects: topography, railroad curves, earth work, construction and maintenance of roads, water works and sewerage systems, etc.

It is believed that the engineering elective will equip the student to enter a comparatively new field, that of landscape engineering,

* While these two electives are entirely distinct, the student electing engineering is strongly advised to elect mathematics also.

which is coming more and more prominently before the public attention; for, with the increasing consideration which is being paid to the public health and the development and beautifying of our towns and cities, come fresh needs and opportunities.

Chemical Department.

Instruction in general agricultural and analytical chemistry and mineralogy is given in the laboratory building. Thirteen commodious rooms, well lighted, ventilated and properly fitted, are occupied by the chemical department.

The lecture room, on the second floor, has ample seating capacity for seventy students. Immediately adjoining it are four smaller rooms, which serve for storing apparatus and preparing material for the lecture table.

The laboratory for beginners is a capacious room on the first floor. It is furnished with forty working tables. Each table is provided with sets of wet and dry re-agents, a fume chamber, water, gas, drawer and locker, and apparatus sufficient to render the student independent of carelessness or accident on the part of others working near by; thus equipped, each worker has the opportunity, under the direction of an instructor, of repeating the processes which he has previously studied in the lecture room, and of carrying out at will any tests which his own observation may suggest.

A systematic study of the properties of elementary matter is here taken up, then the study of the simpler combinations of the elements and their artificial preparation; then follows qualitative analysis of salts, minerals, soils, fertilizers, animal and vegetable products.

The laboratory for advanced students has tables for thirty workers, with adequate apparatus. This is for instruction in the chemistry of various manufacturing industries, especially those of agricultural interest, as the production of sugar, starch, fibres and dairy products; the preparation of plant and animal foods, their digestion, assimilation and economic use; the official analysis of fertilizers, fodders and foods; the analysis of soils and waters, of milk, urine and other animal and vegetable products.

The balance room has four balances and improved apparatus for determining densities of solids, liquids and gases.

Apparatus and Collections. — Large purchases of apparatus have recently been made. Deficiencies caused by the wear and break-

age of several years have been supplied and the original outfit increased. The apparatus includes balances, a microscope, spectroscope, polariscope, photometer, barometer and numerous models and sets of apparatus. The various rooms are furnished with an extensive collection of industrial charts. A valuable and growing collection of specimens and samples, fitted to illustrate different subjects taught, is also provided. This includes rocks, minerals, soils, raw and manufactured fertilizers, foods, including milling products, fibres and other vegetable and animal products and artificial preparations of mineral and organic compounds. Series of preparations are used for illustrating the various stages of different manufactures from raw materials to finished products.

Library.

This now numbers 17,810 volumes, having been increased during the year, by gift and purchase, 730 volumes. It is placed in the lower hall of the chapel-library building, and is made available to the general student for reference or investigation. It is especially valuable as a library of reference, and no pains will be spared to make it complete in the departments of agriculture, horticulture, botany and the natural sciences. It is open a portion of each day for consultation, and an hour every evening for the drawing of books.

PRIZES.

Burnham Rhetorical Prizes.

These prizes are awarded for excellence in declamation, and are open to competition, under certain restrictions, to members of the sophomore and freshman classes.

Flint Prizes.

Mr. Charles L. Flint of the class of 1881 has established two prizes, one of thirty dollars and another of twenty dollars, to be awarded, at an appointed time during commencement week, to the two members of the junior class who may produce the best orations. Excellence in both composition and delivery is considered in making the award.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first and second prize, to be called the Grinnell agricultural prizes, in honor of George B. Grinnell, Esq., of New York. These two prizes are to be paid in cash to those two members of the graduating class who may pass the best written and oral examination in theoretical and practical agriculture.

Hills Botanical Prizes.

For the best herbarium collected by a member of the class of 1897 fifteen dollars is offered, and for the second best a prize of ten dollars; also a prize of five dollars for the best collection of dried plants from the college farm.

The prizes in 1896 were awarded as follows: —

Burnham Rhetorical Prizes: John P. Nickerson (1898), first; Randall D. Warden (1898), second; Dan A. Beaman (1899), first; John R. Dutcher (1899), second.

Flint Oratorical Prizes: Charles I. Goessmann (1897), first; Lafayette F. Clark (1897), second; John A. Emrich (1897), most honorable mention.

Grinnell Agricultural Prizes: Harry H. Roper (1896), first; Henry W. Moore (1896), second.

Hills Botanical Prizes: James F. Hammar (1896), first; Lucius J. Shepard (1896), second.

Collection of Woods: Asa S. Kinney (1896).

Military Prizes: gold medal, presented by I. C. Greene, '94, Charles A. Peters (1897); military suit, presented by Alfred Glynn, Amherst, Alexander Montgomery, Jr. (1898).

Freshman Botanical Prize: Charles M. Walker (1899).

RELIGIOUS SERVICES.

Students are required to attend prayers every week-day at 8 A.M. and public worship in the chapel every Sunday at 10.30 A.M. Further opportunities for moral and religious culture are afforded by a Bible class taught by one of the professors during the hour preceding the Sunday morning service and by religious meetings held on Sunday afternoon and during the week, under the auspices of the College Young Men's Christian Association.

LOCATION.

Amherst is on the New London Northern Railroad, connecting at Palmer with the Boston & Albany Railroad, and at Miller's Falls with the Fitchburg Railroad. It is also on the Central Massachusetts Railroad, connecting at Northampton with the Connecticut River Railroad and with the New Haven & Northampton Railroad.

The college buildings are on a healthful site, commanding one of the finest views in New England. The large farm of three hundred and eighty-three acres, with its varied surface and native forests, gives the student the freedom and quiet of a country home.

REPORTS.

GIFTS.

From GEORGE R. FOULKE of West Chester, Pa., Chester White boar.

THE BARBER ASPHALT PAVING COMPANY of New York, cabinet containing an economic exhibit of asphalt and its compounds as used for asphalt paving, together with sundry views of asphalt streets, and a bibliography of the subject.

THE CATSKILL SHALE BRICK AND PAVING COMPANY, sample shale paving brick.

H. D. GRAVES of Sunderland, maple burl log.

GEORGE CRUICKSHANKS of Fitchburg, natural graft, pine; also photograph of same.

L. R. ALEXANDER (M. A. C., School of Agriculture, '96) of East Northfield, sassafras log, and collection of insects.

GEORGE TSUDA (M. A. C., '96) of Tokyo, Japan, collection of bamboos mounted and catalogued, with description.

S. SASTRÉ (M. A. C., '96) of Tabasco, Mexico, collection of insects.

PHILIP H. SMITH, Jr. (M. A. C., '97) of South Hadley Falls, collection of insects.

JAMES PAGE of Amherst, peacock.

CHARLES I. GOESSMANN (M. A. C.,'97) of Amherst, collection of birds' eggs and nests.

Mrs. H. A. HOLT of Amherst, collection of birds' eggs and nests.

LEACH, SHEWELL & SANBORN of Boston, "Paradise Lost."

ANDREW CARNEGIE of Pennsylvania, "Science of Nutrition and Art of Cooking in the Aladdin Oven."

Dr. MAERCKER of Germany, "Uber die Phosphorsaüre-wirkung des Knochenmehle."

CHARLES E. BEACH (M. A. C., '82) of Hartford, Conn., "Reports of Connecticut Dairy Commissioner."

A. D. F. HAMLIN of New York, "Text-book of the History of Architecture."

From H. N. LEGATE (M. A. C., '91) of Boston, "Report of Board of Metropolitan Park Commissioners."

FERRIS PUBLISHING COMPANY of Albany, N. Y., one volume "Poultry Monthly."

Miss ELEANOR A. ORMEROD of Spring Grove, England, "Nineteenth Report of Observations on Injurious Insects."

WM. H. CALDWELL (M. A. C., '87) of Peterboro, N. H., "Guernsey Breeders' Year Book."

Hon. RICHARD W. IRWIN of Northampton, six volumes State documents.

NEWTON SHULTIS (M. A. C., '96) of Medford, "Discovery and Conquest of the New World."

CHARLES P. LOUNSBURY (M. A. C., '94) of Cape Town, Africa, "An African Farm;" "Dreams;" "Handbook of Cape and South Africa;" "Report of Government Entomologist."

JOSEPH E. POND, Esq., of North Attleborough, four volumes "Bee Journals."

ASA W. DICKINSON (M. A. C., '74) of Jersey City, N. J., ten volumes "Works of Eugene Field."

His Highness the MAHARAJAH OF JEYPORE, India, seven volumes "Jeypore Portfolio of Architectural Details."

HERBERT S. CARRUTH (M. A. C., '75) of Ashmont, "Three Episodes of Massachusetts History;" "Memoirs of Robert Lee."

Hon. GEORGE F. HOAR of Worcester, six volumes government reports.

CHARLES S. PLUMB (M. A. C., '82) of Lafayette, Ind., three volumes "Indiana Dairy Reports."

VERNON L. KELLOGG, "New Mallophaga," two parts.

WM. TRELEASE of St. Louis, Mo., "Sturtevant Prelinnæan Library of the Missouri Botanical Garden."

Hon. FREDERICK H. GILLETTE of Springfield, three volumes government documents.

CYRUS H. MCCORMICK of Chicago, Ill., "Inventors."

J. H. BENTON, "Public Libraries as a Means of Education."

ROBERT H. SMITH (M. A. C., '92) of Amherst, "Beside the Bonnie Brier Bush;" "A Singular Life."

FRANK A. BATES of Malden, "Game Birds of North America."

J. D. W. FRENCH of Boston, four volumes "Index Kewensis."

JOHN R. PERRY (M. A. C., '93) of Boston, "Primer of College Foot-ball."

Different college organizations, group pictures of the same.

TREASURER'S REPORT.

Report of George F. Mills, *Treasurer Massachusetts Agricultural College, from Jan. 1, 1896, to Jan. 1, 1897.*

	Received.	Paid.
Cash on hand Jan. 1, 1896,	$7,801 46	–
State treasurer,	14,666 66	–
Morrill fund,	–	$1,000 00
Term bill,	3,808 20	710 88
Horticultural department,	5,419 10	7,337 81
Farm,	5,683 18	9,439 66
Expense,	1,452 23	8,679 27
Salary,	250 00	27,145 76
Endowment fund,	11,185 02	–
State scholarship fund,	15,000 00	–
Chemical laboratory,	1,712 64	1,349 99
Botanical laboratory,	84 50	129 15
Entomological laboratory,	38 00	13 98
Zoölogical laboratory,	68 00	77 97
Labor fund,	5,000 00	4,562 02
Gassett scholarship fund,	65 00	30 00
Whiting Street fund,	56 90	135 00
Grinnell prize fund,	40 00	40 00
Mary Robinson fund,	35 84	25 00
Burnham emergency fund,	200 00	559 30
Hills fund,	356 16	209 55
Extra instruction,	–	437 50
Advertising,	–	661 34
Library fund,	404 59	404 59
Investment, N. Y. C. & H. R. R.R.,	4 00	–
Insurance,	11 25	1,198 15
Insurance, barn,	–	2,509 16
Insurance, vehicles, tools, etc.,	–	101 70
Electric plant,	730 88	2,075 75
Dairy equipment,	–	930 10
Cash on hand Jan. 1, 1897,	–	4,309 98
	$74,073 61	$74,073 61

This is to certify that I have this day examined the accounts of George F. Mills, treasurer Massachusetts Agricultural College, from Jan. 1, 1896, to Jan. 1, 1897, and find the same correct, properly kept, and all disbursements vouched for, the balance in the treasury being four thousand three hundred and nine and ninety-eight one-hundredths dollars ($4,309 98), which sum is shown to be in the hands of the treasurer.

CHARLES A. GLEASON, *Auditor.*

Amherst, Dec. 29, 1896.

Cash Balance, as shown by the Treasurer's Statement, belongs to the Following Accounts:

Gassett scholarship fund,	$61 02
Mary Robinson fund,	23 92
Grinnell prize fund,	20 00
Hills fund,	190 34
Labor fund,	717 42
General fund,	3,297 28
	$4,309 98

Bills receivable Jan. 1, 1897.

Term bill,	$931 18
Horticultural department,	346 89
Farm,	335 12
Expense,	79 64
Electric plant,	130 87
Chemical laboratory,	338 40
Botanical laboratory,	6 00
Zoölogical laboratory,	24 00
Entomological laboratory,	12 00
	$2,204 10

Bills payable Jan. 1, 1897.

Term bill,	$44 07
Horticultural department,	32 39
Farm,	3,227 54
Electric plant,	270 41
Expense,	1,239 58
Chemical laboratory,	257 19
Labor fund,	5 88
	$5,077 06

Inventory — real estate.

Land (Estimated Value).

College farm,	$37,000 00	
Pelham quarry,	500 00	
Bangs place,	1,750 00	
Clark place,	4,500 00	
		$43,750 00

Buildings (Estimated Value).

Drill hall,	$5,000 00	
Powder house,	75 00	
Gun shed,	1,500 00	
Stone chapel,	30,000 00	
South dormitory,	35,000 00	
North dormitory,	25,000 00	
Amounts carried forward,	$96,575 00	$43,750 00

Amounts brought forward,	$96,575 00	$43,750 00
Chemical laboratory,	8,000 00	
Entomological laboratory,	3,000 00	
Farm house,	2,000 00	
Horse barn,	5,000 00	
Farm barn and dairy school,	33,000 00	
Graves house and barn,	2,500 00	
Boarding-house,	2,000 00	
Botanic museum,	4,500 00	
Botanic barn,	2,500 00	
Tool house,	2,000 00	
Durfee plant house and fixtures,	12,000 00	
Small plant house, with vegetable cellar and cold grapery,	4,700 00	
President's house,	6,500 00	
Dwelling-houses, purchased with farm,	5,000 00	
		189,275 00
		$233,025 00

PERSONAL PROPERTY.

Electric plant,	$6,500 00
N. Y. C. & H. R. R.R. stock,	100 00
Botanical department,	3,610 00
Horticultural department,	7,218 13
Farm,	16,637 25
Chemical laboratory,	2,101 00
Botanical laboratory,	2,056 53
Zoölogical laboratory,	1,800 00
Natural history collection,	5,186 00
Veterinary department,	1,615 66
Physics and mathematics,	4,513 00
Agricultural department,	2,675 00
Dairy equipment,	900 00
Library,	17,810 00
Fire apparatus,	300 00
Furniture,	600 00
Books in treasurer's office,	250 21
	$73,872 78

SUMMARY.

Assets.

Total value of real estate, per inventory,	$233,025 00
Total value of personal property, per inventory,	73,872 78
Bills receivable,	2,204 10
	$309,101 88

Liabilities.

Bills payable,	5,077 06
	$304,024 82

Maintenance Funds.

Technical educational fund, United States grant,	$219,000 00
Technical educational fund, State grant, . .	141,575 35
	$360,575 35

Two-thirds of the income from these funds is paid to the treasurer of the college and one-third to the Institute of Technology. Amount received by the college treasurer from Jan. 1, 1896, to Jan. 1, 1897, ...	$11,185 02
Morrill fund, in accordance with act of Congress, approved Aug. 30, 1890. Amount received in 1896, ...	14,666 66
Hills fund, the gift of Messrs. L. M. and H. F. Hills of Amherst, now amounts to $8,542. By conditions of the gift the income is used for the maintenance of a botanic garden. Income from Jan. 1, 1896, to Jan. 1, 1897, . .	356 16
Annual State appropriation, $10,000. This sum was appropriated for four years by the Legislature of 1889, continued for another four years by the Legislature of 1892, and again by the Legislature of 1896, for the endowment of additional chairs of instruction and for general expense. Five thousand dollars of this sum was set apart as a labor fund, to be used in payment of labor performed by needy and worthy students. Amount received from annual State appropriation for college expense from Jan. 1, 1896, to Jan. 1, 1897,.	5,000 00
Amount received as labor fund	5,000 00

Scholarship Funds.

State scholarship fund, $10,000. This sum was appropriated by the Legislature of 1896, and is paid to the college treasurer in quarterly payments. Amount received from Jan. 1, 1896, to Jan. 1, 1897, ...	10,000 00
Whiting Street fund, $1,000. This fund is a bequest without conditions. To it was added, by vote of the trustees in January, 1887, interest accrued on the bequest, $260. Amount of the fund Jan. 1, 1897, $1,260. Income from Jan. 1, 1896, to Jan 1, 1897, ...	56 90
Gassett scholarship fund, $1,000. This sum was given as a scholarship by Hon. Henry Gassett. Income from Jan. 1, 1896, to Jan. 1, 1897, ...	65 00
Mary Robinson fund, $858. This fund was given without conditions. The income from it has been appropriated for scholarships to needy and worthy students. Income from Jan. 1, 1896, to Jan. 1, 1897, ...	35 84
Amount carried forward, ...	$46,365 58

Amount brought forward, ...	$46,365 58

PRIZE FUNDS.

Grinnell prize fund, $1,000. This fund is the gift of Ex-Gov. William Claflin, and is called Grinnell Fund in honor of his friend, George B. Grinnell, Esq. The income from it is appropriated for two prizes to be given to the two members of the graduating class who pass the best examination in agriculture. Income from Jan. 1, 1896, to Jan. 1, 1897,	40 00

MISCELLANEOUS FUNDS.

Library fund for the benefit of the library. Amount of fund, Jan. 1, 1897, $9,825.06.	
Burnham emergency fund, $5,000. This fund is a bequest of Mr. T. O. H P. Burnham, late of Boston, and was made without conditions. The trustees have voted that this fund be kept intact, and that the income from it be used by the trustees for such purposes as they believe to be for the best interests of the college. Income from Jan. 1, 1896, to Jan. 1, 1897, ...	200 00
Income from Jan. 1, 1896, to Jan. 1, 1897, ...	$46,605 58

To this sum should be added amount of tuition and room rent, and receipts from sales from farm and from botanic gardens. These amounts can be learned from treasurer's statement, tuition and room rent being included in term bill account.

Report of the President of the Massachusetts Agricultural College to the Secretary of Agriculture and the Secretary of the Interior, as required by Act of Congress of Aug. 30, 1890, in Aid of Colleges of Agriculture and the Mechanic Arts.

I. Condition and Progress of the Institution, Year ended June 30, 1896.

The college has continued to feel the effects of the hard times, and the attendance has fallen off in a marked degree during the year ending June 30, 1896. Aside from this, the year has been one of prosperity. The personnel of the faculty remains the same, but the course of study has been modified to meet the demands of the hour. It has been deemed unwise to longer carry on the two-years course and it has been discontinued. In its place eleven short winter courses have been substituted, all optional, all free to citizens of the State and all without limitation of entrance examination. These are arranged under the heads of general agriculture, animal husbandry, dairying, fruit culture, floriculture, market gardening, botany, chemistry, zoölogy. Three new elective courses have been offered in engineering, mathematics and advanced English.

Under appropriations from the State the following buildings have been erected: a laboratory, at a cost of $3,000, two stories high, thirty-two by thirty-six feet, containing stands and appliances adequate for instruction of eighteen to twenty students in economic entomology; a gun room, at a cost of $1,800, twenty-eight by sixty feet, providing shelter for the new breech-loading steel cannon issued by the war department, and a shooting gallery for practice during the winter months. In addition to the above, under legislative appropriation of $5,500, the college domain has been increased by the purchase of twenty acres for use in the horticultural department.

II. Receipts for and during the Year ended June 30, 1896.

1. Balance on hand July 1, 1895,	$578 96
2. State aid: (*a*) Income from endowment,	3,913 60
(*b*) Appropriations for building or other special purposes,	10,300 00
(*c*) Appropriation for current expenses,	15,000 00
Amount carried forward,	$29,792 56

Amount brought forward,	$29,792 56
3. Federal aid: (*a*) Income from land grant, act of July 2, 1862,	7,300 00
(*b*) For experiment stations, act of March 2, 1887,	15,000 00
(*c*) Additional endowment, act of Aug. 30, 1890,	14,000 00
4. Fees and all other sources,	1,000 00
Total receipts,	$67,092 56

III. Expenditures for and during the Year ended June 30, 1896.

1. College of Agriculture and Mechanic Arts,	$25,004 16
2. Experiment Station,	15,000 00
Total expenditures,	$40,004 16

IV. Property and Equipment, Year ended June 30, 1896.

Agricultural department: —

Value of buildings,	$250,940 00
Value of other equipment,	$71,943 80
Total number of acres,	404
Acres under cultivation,	260
Acres used for experiments,	60
Value of farm lands,	$45,000 00
Amount of all endowment funds,	$360,575 35

V. Faculty during the Year ended June 30, 1896.

	Male.	Female.
1. College of Agriculture and Mechanic Arts, collegiate and special classes,	18	-
2. Number of staff of Experiment Station,	18	1
Total, counting none twice,	28	1

VI. Students during the Year ended June 30, 1896.

1. College of Agriculture and Mechanic Arts, collegiate and special classes,	161
2. Graduate courses,	15
Total, counting none twice,	176

VII. Library, Year ended June 30, 1896.

1 Number of bound volumes June 30, 1896,	*17,365
2. Bound volumes added during year ended June 30, 1896,	*982
Total bound volumes,	17,365

* Pamphlets, none.

FARM REPORT.

The farm operations of the past season have been conducted along the same general lines as for several years; the objects in view being the systematic improvement of the estate, the illustration of the best methods in performing all farm operations and in the management of live stock and dairy, and the carrying out of such experiments in all departments as may seem desirable.

"The meteorological conditions," reports the farm superintendent, Mr. Jones, "have, in the main, been favorable for the growth of the more important farm crops; yet the cold, dry weather of the early spring retarded the growth of the onion and root crops, and materially lessened the yield of hay on the upland mowings."

To this statement, I believe, should be added that the frequent rains and excessive heat of the latter part of the summer undoubtedly decreased the yield of sound onions, mangels and turnips, as not all parts of the land devoted to them are well drained.

The number of acres in the various crops was as follows: hay, 80; corn for the silo, 25⅓; potatoes, 8½; corn for husking, 5; millet, 4½; onions, 2¾; Swedes, 1¼; mangels, 1; carrots, 1; celery, 1; soya beans, 4; horse beans, 1; oats and vetches, 2; a total of 137⅓ acres.

The several fields and products were as follows: —

Hay. — Old fields (between college buildings and the county road), estimated, 30 acres: hay, 54 tons, 121 pounds; rowen, 11 tons; middle flat, 12 acres: hay, 21 tons, 160 pounds; rowen, 7 tons, 675 pounds; south flat, 32 acres: hay, 52 tons, 805 pounds; rowen, 26 tons, 565 pounds; Hatch slope, about 6 acres: hay, 13 tons, 1,030 pounds; rowen, 7 tons. This gives a total from about 80 acres of 194 tons and 556 pounds, or 2.43 tons per acre. The yield in one field of 5½ acres of timothy and the rowen crop in all the old fields was seriously decreased by the ravages of the army worm, which are alluded to later in this report somewhat more in detail.

Potatoes. — North of Target Butt, 8½ acres: merchantable tubers, 1,041 bushels; small tubers, 273 bushels.

Corn for the Silo. —Twenty-five and one-third acres: fodder weighed into the silo, 279 tons, 70 pounds.

Oats and Vetch Hay. — North flat, 2 acres: 5 tons, 1,000 pounds.

Japanese Barn-yard Millet. — North flat, 1 acre: 4 tons, 1,000 pounds hay.

Corn for Husking. — Sand knoll, three-quarters of an acre: grain, 46.8 bushels; stover, 2.25 tons; south flat, 4¼ acres: grain, 319 bushels; stover, 24.5 tons.

Carrots. — South flat, 1 acre: 14 tons, 145 pounds.

Mangels. — South flat, 1 acre: 11.2 tons.

Onions. — South flat, 2½ acres: sound onions, 282.6 bushels.

Barn-yard Millet. — Campus slope, 3 acres: 37.4 tons, weighed into the silo.

Soya Beans. — Campus slope, 4 acres: green fodder for silo, 41 tons, 620 pounds.

Horse Beans. — North flat, 1 acre: 5 tons, 1,541 pounds green fodder.

Celery. — North flat, 1 acre: 200 dozen bunches.

The prices of all farm products last year were so very low that the farm management found itself at the beginning of the past year upon so poor a financial basis that it was resolved to carry on the operations of this year almost entirely without commercial fertilizers. This seemed the more possible in view of the fact that the farm was once more very nearly fully stocked, and was therefore producing a large amount of manure. This manure was from the nature of the case in most instances applied fresh but a relatively short time before planting the crops, and was undoubtedly, therefore, not in condition to produce its full effect upon the crops of the past season. Then, too, the fact that the farm was so lightly stocked for the two years preceding the last has forced us to use less manure than usual in the recent past. These facts, together with the unfavorable effects of season due to imperfect drainage in some fields, account for a lower average in most staples than we have produced in recent years.

The system of manuring followed with the several crops is shown in the table: —

Application per Acre.

	Corn for Silo.	Corn for Husking.	Potatoes.	Soya Beans.	Japanese Barn-yard Millets.	Horse Beans.	Onions.	Swedes.	Mangels.	Carrots.	Celery.
Manure (cords),	4	4	–	4	4	6	9	–	6	10	6
Basic slag (pounds),	–	–	–	–	–	–	–	–	–	–	700
Bone meal (pounds),	–	–	–	–	–	–	–	–	–	–	800
Double sulphate potash and magnesia (pounds).	–	–	–	–	–	–	–	–	–	–	200
Dry ground fish (pounds),	–	–	–	–	–	–	–	–	–	–	300
Ashes (pounds),	–	–	–	–	–	–	2,000	–	–	–	–
Lime (pounds),	–	–	–	–	–	–	–	–	400	400	–
Coarse salt (pounds),	–	–	–	–	–	–	–	–	200	–	–

Corn for the Silo. — Our yield is the smallest average that we have ever produced, viz., but little over 11 tons. The unfavorable conditions other than the small application of manure and the lack of fertilizer already alluded to in a general way were the following: —

1. Poor seed, purchased from such source that it was believed to be undoubtedly good, and unwisely not tested because it looked bright.

2. The excessive use of town sewage on the field adjoining the college estate on the south, which renders several acres of the field where we produced most of our corn for the silo so wet that but little corn grew there.

3. A section of 2 acres from the middle of a field planted for husking on the south flat has not yet been drained; and the crop from this was so poor that it was cut and put into the silo, thus increasing the acreage of corn ensiled, but not much increasing the weight of product.

4. The old building site (barn and farmhouse) makes up 3½ acres of the total ensiled, and of course did not produce a full crop.

Japanese Barn-yard Millet. — Three acres on the campus slope, receiving at the rate of 4 cords per acre of barn-yard manure spread during the winter, gave a product of 37.4 tons, — rather more than 12 tons per acre. Analyses in previous years have shown this fodder to equal Indian corn in food value. The

crop of this year has been put into the silo. It was sown broadcast, and of course received no culture.

Medium Green Soya Beans. — Four acres on the campus slope, manured as for the millet, were planted to this crop. The seed was planted with the Eclipse corn planter, about 12 to 15 seeds to the foot of row; rows 2½ feet apart. The growth was fine, and the crop cost but little labor to raise. The product was at the rate of 10.3 tons per acre. It was put into the silo in alternate layers with Indian corn, when the pods were filled but before the beans had hardened. It was put in in the proportion of one part of the beans to two parts of the corn. It is confidently anticipated that this will make a well-balanced silage.

Horse Bean. — One acre in good strong loam on the north flat was planted to this crop. It received an application of 6 cords of manure, spread after ploughing and harrowed in. The beans were planted in rows 1½ feet apart, 6 to 8 seeds to the foot, with a hand planter. The foliage blighted, and the yield (weighed as it was cut and fed green to the cows from day to day, being in bloom at the time) was only 5.8 tons. After two years' trial, I have decided that this crop is not likely to prove valuable with us.

New Implements. — The Robbins' potato planter was used in putting in our potatoes this year, with very great satisfaction. For its operation, a heavy pair of horses, a man and a boy are needed. It applies the fertilizer and plants the cut potatoes in an excellent manner. It is quite necessary that potatoes be cut evenly and rather small. The pieces are as a rule dropped with perfect regularity and all covered. This is not always the case with other planters. Three rows, planted, for the purpose of comparison, with the Aspinwall planter, showed many skips, and gave a product of 18 bushels; while the adjacent three rows, planted with the Robbins, showed hardly a skip, and gave a product of 37½ bushels. In justice to the Aspinwall planter, it should be stated that no effort was made to cover by hand the tubers not covered by the machine, and, further, that the pieces were perhaps rather too small for its best work. It was operated by one man, while the Robbins required also a boy. I do not attach great importance to the exact relations of the above figures giving yields, but I am fully convinced, as the result of a four years' trial, that we cannot in Massachusetts afford to use the Aspinwall planter, as under the best conditions there are too many failures to deposit and cover the seed.

Corn Harvester. — The farm superintendent, Mr. Jones, reports concerning the McCormick corn harvester as follows: "The en-

tire crop of field and ensilage corn was cut this year with the McCormick corn harvester. The work was well done, and the method proved to be far more economical than hand labor. About six acres were found to be a fair average for a day's work. The corn, being bound in compact bundles, greatly facilitated the work of hauling and passing through the ensilage cutter."

Live Stock.

Horses. — Our horses and colts have been uniformly in a perfect condition of health throughout the year. We now own the following animals: Percherons, 1 stallion, 1 mare and 2 stallion colts; Percheron three-quarters blood, 1 stallion and 2 mare colts; one-half Percheron, 1 mare; ordinary work horses, 2 geldings and 2 mares; French coach, 1 stallion colt and 1 mare colt; total, 14.

Neat Cattle. — Shorthorn, 1 bull and 2 females; Guernsey, 2 bulls and 2 females; Jersey, 1 bull and 2 females; Ayrshire, 1 bull and 2 females; Holstein-Friesian, 1 bull and 2 cows; Aberdeen-Angus, 1 cow and 1 stag; Dakota cows, 34; Dakota heifers, 14; grade Hereford, 1 heifer; grade calves, 9; total, 76.

Southdown Sheep. — One breeding buck, 2 yearling bucks, 31 breeding ewes, 4 buck lambs and 4 ewe lambs; total, 42.

Swine. — Tamworth, 1 boar and 6 pigs; Chester White, 1 boar and 1 sow; Cheshire, 1 boar; Berkshire, 1 boar and 1 sow; Poland-China, 1 sow; total, 13.

The health of cattle and sheep has been good throughout the year, but there have been a few abortions among the cows, the cause of which is obscure. It is thought that it may be due to slipping upon the cement floor of the stable; but I do not feel at all confident that this is the case. The cattle were all retested with tuberculin during last winter, and not a case of tuberculosis was found. There has, indeed, been not the slightest evidence of this dread disease among our stock since we have occupied the new barn.

In restocking with swine we were so unfortunate as to get hog cholera with one of the animals; and as a result we lost by this disease a Chester White boar and a litter of twelve pigs, a Poland-China boar, a Cheshire sow, a Medium Yorkshire sow and six Tamworth sucking pigs. By isolation of infected animals and thorough disinfection we were able to check the disease within a short time, but not before it had seriously injured our stock. Not the least of the ill consequences is the failure to breed on the part of the animals that survived.

Cash Receipts of the Year.

The total receipts of the year for products sold and for labor performed by farm teams and men amount to nearly $6,000. The leading items contributing to this total are the following: beef, $886.38; sheep and lambs, $95.45; dairy products, $1,790.10; hay, $561.72; potatoes, $264.26; onions, $81.75; celery, $112.48; corn, $15.15; wood, $802.26; stone, $92.25; ice, $122.47; work, $580.45.

Seeding to Grass.

The method of seeding to grass in the standing corn has invariably given such satisfactory results that we have come to follow it almost to the entire exclusion of other methods. The seed is sown in showery weather the latter part of July, as a rule following immediately after the last cultivation. The men in sowing walk in every row, casting the seed three rows wide. The land is thus all sown over three times, and the result is very even distribution of the seed. This year the 17 acres on the campus slope were worked the last time (beginning July 25) with Breed's one-row weeder, and the seed sown immediately after. The mixture used per acre was as follows: —

	Pounds.
Timothy,	18
Red top,	8
Kentucky blue-grass,	5
Meadow fescue,	6
Mammoth red clover,	6
Alsike clover,	3

The seed came quickly and evenly, and the field promises a good crop another season.

The land which was occupied by the barn-yard millet and soya beans was ploughed after these crops were removed, and the land then sown with the mixture above given.

On the site of the old barn and farmhouse there were so many stones that it was thought better to remove the corn, plough and then sow. This was done, the following being the mixture of seeds used per acre: —

	Pounds.
Orchard grass,	20
Kentucky blue-grass,	4
Meadow fescue,	6
English rye-grass,	4
Tall oat grass,	6
Awnless brome grass,	4

Clover will be sown here in the spring.

Rape and White Mustard.

At the last cultivation of the corn on the south flat, 4 acres were sown with Dwarf Essex rape at the rate of 2 pounds per acre, and 3 acres with white mustard, at the rate of 7 pounds per acre. Both crops came up evenly, but, probably on account of being shaded by the corn, did not make a large growth, and were not pastured. Both were ploughed under after the corn was removed.

Permanent Improvements.

The work of fitting the lot south of the Plainville road for pasture has been prosecuted as energetically as our resources would permit. The lot has been fenced in a substantial manner, our share of the lines amounting to a total length of 5,400 feet. We have put up a five-strand barbed wire fence with chestnut posts. Considerable work in clearing the lot of brush has also been done.

The grass seeds sown last summer and fall after burning the lot started well, and effectually smothered out the inferior natural grasses, sedges and weeds. The lot furnished a large share of the food needed during the summer by our herd of 40 cows.

A lane 84 rods long and 27 feet wide, leading from the barn to the pasture, has been fenced with Page's woven-wire fence, with chestnut posts. The style of fence employed is 56 inches high. It combines neatness, strength and durability in a remarkable degree, and has proved entirely satisfactory.

The remainder of the drive which led to the upper floor of our old barn has been carted away, about 200 loads of gravel having been taken out and applied to the college roads. Most of the stones which yet remained upon this old building site have also been picked up and carried away.

The Army Worm.

Early in July we found a field of timothy seeded the previous August was seriously attacked by army worms, which before they were discovered had eaten a large share of the leaves and heads of the grass. A furrow as deep as could be turned with a heavy plough drawn by four horses was put around three sides of the piece, the fourth side being bounded by a brook. It so happened that the grass had been cut from a strip about one rod wide under the trees next the road on two sides, and the young grass here was powdered with Paris green, which application was, I believe, useless, as the worms when marching passed across without feeding.

At the same time the machines were started and the timothy was cut. This was in the forenoon. At about three o'clock in the afternoon the worms began to move out of the field in enormous numbers. They did not go into the brook, but poured into the furrows in countless myriads. Here they were checked, the side of the furrow farthest from the field having been cut as smooth as possible and with somewhat of a slope against the worms in their efforts to climb out of it. The furrow was not, however, a perfect barrier; many worms were found to be climbing out. Accordingly a line of coal tar was put in the bottom of the furrow round the three sides of the field. This was a great advantage. Many worms were killed by it; but the tar soon became filled with dead and dying worms, and in part soaked into the ground, and it was found that worms were again crossing. We then attacked them with pure kerosene oil, applied with a knapsack pump and spraying nozzle. We went over the furrow twice in this way that day, and found this method very effective. By this time it was dark, and the worms had mostly ceased moving.

The next day at about the same hour the movement of worms again began in even greater numbers than the first day. We again used tar and kerosene, and with equally satisfactory results.

Meanwhile the timothy had been cured and hauled to the barn, and the next morning before six o'clock we had applied Paris green to the entire six acres, using two Leggett's guns and putting on about three pounds of green to the acre. By noon of that day there were few worms in the field alive, and we had succeeded perfectly in keeping them out of adjoining fields of corn and grass, and literally annihilated the colony.

It was later found that there were some worms in other fields of grass which had been cut earlier, where they fed upon the new growth, preferring that of timothy and orchard grass. These worms caused a serious shortage in our rowen crop in all these fields. Where the worms were thick we applied some Paris green, which, as in the case of the larger field of timothy, was effective. There can be no danger in applying this poison soon after the main crop is removed, as in these cases, for it is sure to be all washed off before any rowen is ready to cut, if there are rains; and if there are no rains there will be no rowen.

It is a matter of grave uncertainty whether we shall be troubled with army worms next season. It is said they are seldom or never seriously troublesome two years in succession in the same place; but whether the past season is to be counted as *the serious one* we are unable to decide. The trouble was surely bad enough, but

of course not nearly as serious as such incursions sometimes are. Burning the stubble in the spring is said to be useful in the case of threatened attacks of such worms.

In conclusion, I desire to testify to the efficient, faithful and skilful services of the farm superintendent, Mr. E. A. Jones, who brings to this important work in his alma mater unusual natural qualifications and an extended experience. To his careful management in my absence since August has been largely due such measure of success as has attended the farm operations.

WILLIAM P. BROOKS,
Professor of Agriculture.

HALLE A. S., GERMANY, Dec. 7, 1896.

MILITARY DEPARTMENT.

AMHERST, MASS., Dec. 31, 1896.

To President H. H. GOODELL, *Massachusetts Agricultural College.*

SIR: — I have the honor to submit my report of the military department of the college for the year ending Dec. 31, 1896.

In compliance with S. O., No. 173, H. Q. A., A. G. O., Washington, July 24, 1896, I relieved First Lieut. Walter M. Dickinson, Seventeenth Infantry, on the sixteenth of August last.

Drills commenced on September 3, and have been continued during the term on Monday, Tuesday and Thursday of each week. The command is organized in a battalion of three companies. A band has not been formed, owing to lack of talent; but it is hoped that a drum and trumpet corps or a drum and fife corps will be started early in January.

The companies have been instructed in all of the drill regulations up to battalion, but thus far there has not been opportunity for extended order drill, owing to lack of time. A very satisfactory state of efficiency has, however, been reached. Two companies were consolidated for platoon drill, each senior having an opportunity to drill it as captain and as chief of platoon. The seniors also received instruction in signalling with flag and heliograph, and with one or two exceptions are proficient.

All the companies received instruction in artillery and bayonet exercise, and during the latter part of the term considerable progress has been made in battalion drill.

There has been no target practice thus far, owing to the unsafe condition of the target pit and butt. Specifications for repairing the range, so that the markers will be able to work without danger to life or limb, will at an early date be submitted for your approval. Gallery practice and pointing and aiming drill will commence early in 1897.

The college dormitories are in excellent repair and condition, but I cannot recommend too strongly the placing of suitable water-

closets, sinks and bath rooms in north college. I believe this to be the most urgent necessity that has come under my observation since joining here. The present system of janitors is not satisfactory, as the halls, sidewalks, sinks, water-closets, etc., are not kept in a proper state of police, although the responsible persons have been frequently spoken and written to about the matter. I recommend the employment of outside help for work of this character.

I concur most heartily with the recommendations of my predecessor regarding the transformation of the present gun shed into a combination gun shed and armory, and the use of the present armory for bath rooms, lavatories, lockers, etc., in connection with the gymnasium. I would also invite attention to the necessity of painting the outside of the drill hall.

The senior and freshman classes have received one hour theoretical instruction each week. The former have been instructed in drill regulations, including battalion drill, and in signalling with the flag and heliograph. The progress made was very satisfactory. The freshmen were instructed in drill regulations for one-half the time each week, the other half being taken up with a short lecture and discussion on some military subject, such as the Springfield rifle, the 3.2 inch B. L. rifle, infantry fire, customs of the service, articles of war, etc.

The discipline, *esprit* and attendance of the command are excellent, and are due in a great measure to the character of the work done by my predecessor and the unqualified and cordial support given this department by the college authorities.

The following three members of the last graduating class were reported to the Adjutant-General of the army and to the Adjutant-General of the State of Massachusetts as having shown the greatest proficiency in the art and science of war: —

Horace C. Burrington,	*Charlemont.*
Patrick A. Leamy,	*Petersham.*
Francis E. DeLuce,	*Warren.*

The following is a list of the United States property now on hand: —

Ordnance.

2 3.2-inch breech-loading steel guns.
2 8-inch mortars, with implements.
2 gun carriages.
2 gun caissons, with spare wheels.
2 mortar beds.
147 Springfield cadet rifles.
147 sets of infantry accoutrements.
51 headless shell extractors.
2,000 metallic ball cartridges.
2 mortar platforms.
2,000 pasters.
75 paper targets.
30,000 cartridge primers.
20,000 round balls.
1 set reloading tools.
75 pounds of small arms powder.
2 sets of implements and equipments for 3.2-inch breech-loading steel guns.

Signal.

2 heliographs, complete.
6 2-foot white flags.
6 2-foot red flags.
6 canvas cases and straps.
12 joints of staff.

The battalion organization is as follows: —

Commandant.

First Lieut. W. M. Wright, ... Second U. S. Infantry.

Commissioned Staff.

Cadet First Lieutenant and Adjutant, . . . G. D. Leavens.
Cadet First Lieutenant and Quartermaster, . . J. L. Bartlett.
Cadet First Lieutenant and Fire Marshal, . . H. J. Armstrong.

Non-commissioned Staff.

Cadet Sergeant-Major, ... A. Montgomery, Jr.
Cadet Quartermaster-Sergeant, ... J. P. Nickerson.

Company A.

Cadet Captain,	J. M. Barry.
Cadet First Lieutenant,	C. I. Goessmann.
Cadet Second Lieutenant,	G. A. Drew.
Cadet First Sergeant,	L. L. Cheney.
Cadet Sergeant,	R. D. Warden.
Cadet Sergeant,	C. G. Clark.
Cadet Sergeant,	A. G. Adjemian.
Cadet Corporal,	E. M. Wright.
Cadet Corporal,	G. C. Hubbard.

Company B.

Cadet Captain,	J. A. Emrich.
Cadet First Lieutenant,	J. W. Allen.
Cadet Second Lieutenant,	H. F. Allen.
Cadet First Sergeant,	C. F. Palmer.
Cadet Sergeant,	W. S. Fisher.
Cadet Sergeant (Color Sergeant),	J. S. Eaton.
Cadet Corporal,	D. A. Beaman.
Cadet Corporal,	A. A. Boutelle.

Company C.

Cadet Captain,	P. H. Smith, Jr.
Cadet First Lieutenant,	C. A Peters.
Cadet Second Lieutenant,	C. A. Norton.
Cadet First Sergeant,	L. F. Clark.
Cadet Sergeant,	G. H. Wright.
Cadet Sergeant,	C. N. Baxter.
Cadet Corporal,	F. H. Turner.
Cadet Corporal,	J. R. Dutcher.

Respectfully submitted,

W. M. WRIGHT,
First Lieutenant Second Infantry.

THE SPRUCE GALL-LOUSE.

(*Chermes abietis* Linn.)

Prepared by Prof. CHARLES H. FERNALD, Massachusetts Agricultural College.

The spruce gall-louse forms greenish galls on the twigs of various species of spruce, greatly injuring them and giving a very unsightly appearance to the trees. These galls (Plate II., Fig. 5) contain from three to thirty or more cavities, within each of which from ten to thirty of these minute yellowish insects may be found during the months of June and July, adhering to the walls of the cavities. About the middle of July the galls begin to dry, and the cavities opening allow the young gall-lice to escape. They crawl to the leaves, and after molting, their wings appear as shown in Fig. 10, Plate II. The body of the insect in this stage is brownish and the wings are transparent. The posterior end of the body, soon after molting the skin, is covered with a mass of fine white waxy hairs.

These insects soon come to rest on the leaves, and lay a cluster of small yellowish eggs, from twenty to fifty in number, each one being attached by a slender almost colorless thread (Plate II., figs. 4 and 6). The insect dies as soon as she lays her eggs, and her body serves as a protection to them.

The eggs hatch in about two weeks, and the exceedingly minute brownish insects crawl about over the twigs, some coming to rest on the leaves, others at the base of the buds. All of those on the leaves and many of those on the buds die before spring. Those which survive may be found early in May, enveloped in a dense coat of white waxy threads, which is quite conspicuous. These insects lay a large number of eggs which hatch in a few days, and the young, crawling to a gall, come to rest in the crevices and are soon enclosed by the enlarging gall. Here they remain till the opening of the gall allows them to escape, as described above.

Predaceous Enemies.

The larva of the common lace-winged fly (*Chrysopa oculata* Say) has been taken feeding voraciously on the nymphs of this insect as they issued from the galls. This larva, also called the Aphis-lion, is a formidable-looking creature, measuring about a third of an inch from the tips of the long, sickle-shaped jaws with which it grasps its prey to the end of the abdomen. When fully grown the larva spins a nearly spherical white cocoon, from which, after about two weeks, the adult insect, with a slender green body and large delicate-veined wings, emerges.

W. R. Fisher, in his "Forest Protection" (Vol. VI. of Schlich's "Manual of Forestry," page 327), gives as a remedial measure the protection of the smaller insectivorous birds, as tits, the nut-hatch and golden-crested wren. He also states that a spider is an active destroyer of this insect, spinning its web over the galls and preventing the escape of its inmates.

Remedies.

Kerosene emulsion is the popular remedy for plant lice in general, and has been recommended by some for the spruce gall-louse; but it has been given a thorough test here, and failed to destroy the insect. Other experimenters have also been unable to destroy it with kerosene emulsion. Experiments were made with whale-oil soap on spruces growing near the insectary in Amherst. One pound of soap was dissolved in two gallons of water, and the infested trees were sprayed with this solution in April. This proved very effectual, as no insects have since been found on the trees thus treated.

A simple way of holding the insect in check, when not abundant, is to cut off the galls and burn them in the month of June, before the insects leave the cavities.

The following more technical account has been prepared by my assistant, Mr. R. A. Cooley, who has very patiently and successfully worked out the life history of this insect, and made all the studies and experiments on it, under my direction. No attempt has been made to give its foreign history nor references to foreign literature.

I am under obligations to Prof. L. O. Howard for valuable information on the distribution of the insect in this country.

The Spruce Gall-louse.

(*Chermes abietis* Linn.)

The spruce gall-louse, also known as spruce bud-louse, spruce Adelges and spruce Chermes, like many other of our destructive insects, is a native of the old world, and was probably introduced into this country from northern Europe on Norway spruces. The exact date of introduction is not known, but the first mention of it in the United States that I have been able to find is in an article by Dr. Cyrus Thomas, in the "Transactions of the Illinois Horticultural Society" for the year 1876 (page 198). Dr. Thomas described the species provisionally as *Chermes abieticolens* in his third annual report (page 156, 1879). Dr. Packard had previously given a brief description of a species of Adelges occurring in abundance on the spruce in Maine, in his "Guide to the Study of Insects" (page 522), the first edition of which was published in 1869.

In order to learn the distribution of the species in this country, as well as to obtain other information, about five hundred circular letters were sent out to different persons in the United States and Canada. This resulted in the receipt of a large amount of desirable material and information. Only one species of Chermes was received, and the question at once arose whether it was *abietis* or *abieticolens*, as both species were said to be present in the United States. To settle this question, specimens in all stages were sent to Dr. N. A. Cholodkowski, professor of zoölogy in the Forst-Akademie in St. Petersburg, Russia, one of the most eminent authorities on this group of insects, and he determined it to be *Chermes abietis* Linn. From all the material and facts obtained there can be no doubt that *Adelges abieticolens* Thos., no types of which have been preserved, is identical with *Chermes abietis* Linn.

Distribution.

Chermes abietis is widely distributed in the United States, reaching from the Atlantic to the Pacific, but is chiefly confined to the transitional zone, though it has been received in a few instances from the northern edge of the upper austral zone. From what I have been able to learn through correspondence, it appears that the insect is far more common and destructive in New England than elsewhere in the United States. Outside of New England it has been received from Sing Sing, N. Y.; West Park, N. Y.;

Ridgewood, N. J.; State College, Pa.; Toronto, Can.; Denver, Col.; Fort Collins, Col.; Grand Rapids, Mich.; Chicago, Ill., and New Whatcome, Wash.; and it is also said to occur in Oregon. Hon. J. R. Anderson, deputy minister of agriculture, Victoria, British Columbia, wrote to Professor Fernald Oct. 5, 1896, that, after making particular inquiries from the correspondents of his department and from personal observations during his journeys through the country, he was of the opinion that this insect did not occur in British Columbia. He further wrote that he was informed that this or a similar pest was prevalent in the adjoining American States of Washington and Oregon, and that he feared it was only a question of time when it would find its way into British Columbia.

The Species in the Old World.

Buckton, in his "Monograph of the British Aphides" (Vol. IV., page 30), says: "This insect is numerous in many English counties. It also has a wide continental distribution, reaching as far south as Parma in Italy."

Destructiveness.

We have no record that these insects ever kill the trees, but they so generally disfigure them as to make them useless as ornaments or unsalable as nursery stock.

Mr. James Draper, proprietor of the Bloomingdale nurseries at Worcester, Mass., to whom we are indebted for courteous assistance in our study of the species, gave us the following information: "These little burrs made their appearance some three or four years ago and have been increasing some each year, so that I took hold of them in earnest the past year, and dug them out root and branch and burned them. There must have been a hundred trees at least, from six to eight feet in height, that we thus destroyed."

Other reports of the injuries of this insect have been received from different parts of the country. That the insect attacks forest spruces is shown by the following extract from a letter from Prof. C. P. Gillette, Fort Collins, Col., who very kindly sent us specimens from his locality: "This gall, which I send you, along with many others was taken near the timber line on Long's Peak, this State, early in August, by myself. Between 8,000 and 11,000 feet altitude the galls were common, but were most abundant near the timber line, where nearly every twig of Engleman's spruce was terminated by one. The galls were almost entirely green in color,

or more or less rosy. Even the small trailing trees, at the very border of the timber, had hundreds of these galls upon them. I have not seen any of these galls or spruces growing outside the mountains." Numerous other statements of a similar nature have been received, which show that this insect is a serious pest.

Life History and Habits.

At the time the spruces are putting forth new shoots, about the second week of May in this locality, the eggs of this insect, together with the shrivelled body of the dead or dying female, may be found at the base of the buds, enveloped in a white woolly mass, about 3 mm. (one-eighth of an inch) in length. Each cluster contains about three hundred eggs, which are of a light yellow color and .4 mm. (nearly one-sixtieth of an inch) in length, each egg being attached by a very slender transparent stem about twice as long as the greatest diameter of the egg (Plate I., Fig. 9). In about one week these eggs hatch, and the minute nymphs, after remaining in the woolly mass for a few hours, venture out, and, crawling to the young and tender shoots, nestle closely in the cracks at the base of the leaves of the young galls which have already begun to form before their arrival. A very young shoot broken out from the bud scales before any of the eggs have hatched shows the basal leaves on the side where the female passed the winter, distinctly swollen at the base. The starting of the gall must therefore be attributed to the female rather than to the nymphs. It is reasonable to suppose, however, that the nymphs settling in the partially formed gall have some influence on its further development. In the young gall there is nothing to indicate that there will ever be cavities to enclose the nymphs, but as the gall develops it grows over the insects, the cavities gradually close, leaving only a semicircular incision, surrounded by grayish or pinkish pubescence. Young nymphs arriving later sometimes find it difficult to discover a cavity open enough to allow admission. In general, all the nymphs which enter one gall arise from the egg-cluster laid by one female. After the cavity has closed, the space within enlarges, and in a few days the young may be seen closely adhering to the sides, with their heads directed toward the opening.

The young nymphs are oval in form and flattened, .4 mm. (nearly one-sixtieth of an inch) in length, and of a light yellow color, with the legs, antennæ and proboscis slightly darkened. The eyes are black, and the antennæ, which are about as long as the lateral diameter of the head, consist of three segments, the first and

second of which are nearly equal, while the third is regularly ringed and longer than the first two combined. The tarsus has but one segment, from which arises a pair of digitules near the outer end. The first molt occurs when the nymph is about two weeks old, and the molted skin is left attached to the tip of the abdomen. The next two molted skins are pushed off similarly, with the previous skin still attached, leaving three empty skins trailing from the end of the body. By this time all have become crowded and the skins are brushed off, and these, together with globules of liquid matter voided by the nymphs, make a considerable amount of debris. Sometimes a single molted skin at the end of the abdomen becomes distended with these liquid globules and strongly resembles a young nymph, and may sometimes have been mistaken for one.

I have been unable to determine the exact number of molts, but the foregoing facts would indicate that there are at least three before the insect reaches the adult stage.

The full-grown nymph (Plate II., figs. 1 and 2) is 2 mm. (about one-twelfth of an inch) long and 1 mm. wide, with the head, thorax and abdomen not distinctly separated. The head and thorax, together with all appendages, are yellow, but the abdomen is slightly more reddish. The wing pads are tinged with green in the majority of individuals, but in some they are light brown. The whole surface of the body is scantily covered with a white powdery secretion. The head is slightly bi-lobed; eyes large, black and conspicuous (mounts in Canada balsam show the eyes red). No ocelli are present. The antennæ are remote at the base, and have three segments, the third being much the longest. The legs have a protuberance at the end of the tibia, on the inside, on which the insect rests when walking. Abdomen distinctly segmented.

In the early part of August the nymphs have become full grown, and the galls begin to lose their dark-green color and slowly take on a yellowish tinge. The cavities slowly open, and the nymphs crawl out one by one, molt their skins, leaving them attached to the leaves, and crawl on, the wings developing as they go, half an hour being required for them to become fully expanded. The first winged specimens were observed at Amherst August 10. Most of the adults emerged before the 20th, but stragglers continued to appear for some time after. The galls turn from yellowish green to brown as they dry up, and before fall it is difficult to distinguish them from those produced in previous years. The younger and smaller nymphs left in the galls are forced to leave, and, crawling to the leaves, molt, producing under-sized adults.

If for any reason the gall dries up before the usual time, the nymphs appear to be able to transform to the winged individuals prematurely. I have one specimen, dated June 15, which emerged from a nymph bred from a gall on a twig in a bottle of water.

Winged female (Plate II., Fig. 10). — Length from face to tip of closed wings, 2.5 to 3 mm. (from one-eighth to one-tenth of an inch). Greatest width of body, 1 mm. Expanse of wings, 5.5 mm. (about one-fifth of an inch). Head broader than long, not separated from the thorax by a neck, very dark brown above, smoky yellow beneath. Eyes large and black, visible from below and above; ocelli three, one above each eye and one between the bases of the antennæ. Antennæ slightly longer than the width of the head, remote at the base, almost naked, and composed of five segments, of which segment two is the shortest, the others being subequal in length; segments one and two of greater diameter than those succeeding; segments three, four and five irregularly ringed, and having each a raised and smoothed surface near the outer end on the under side. Attachment between segments two and three slender. Prothorax broad and smoky yellow. Between the bases of the fore wings on the top of the thorax are four oval, very dark-brown spots, the outer being the largest; and there are three transverse, white waxy stripes, two in a line and one behind them. Sternal plate dark brown in color. Wings (Plate II., Fig. 8) four in number, the fore wings having the stigma and costal cell distinctly green, the stigma being darker green than the costal cell. There are two discoidal and one stigmatic vein. Hind wings with one more or less distinct oblique vein. The hooklets on the anterior margin are four in number, long and slender. Mouth parts somewhat sunken into the body at the base, extending a little past the anterior edge of the sternal plate. Legs of nearly equal length, spinose, especially on the inner side of the tibiæ. Abdomen lighter in color than the head and thorax, with the posterior end covered with a white flocculent secretion, which extends up the sides of the abdomen toward the thorax.

Newly emerged specimens are of nearly uniform yellowish color, but with age the darker markings become apparent, and later, the head and thorax become a nearly uniform deep brown, while the abdomen retains its yellowish color.

About two days after the female emerges as a perfect insect she begins laying her eggs, having first permanently attached herself to a leaf, generally near the tip, and inserted her mouth parts. Here she stays for the remainder of her life, her dead body serving as a protection for the egg-cluster which she deposits (Plate II.,

Fig. 4, shows an egg-cluster). The number of eggs varies widely, but is generally about forty, never much exceeding fifty, and the process of egg laying occupies about three days. As this process goes on the abdomen becomes much shortened, until finally the space which it occupied is largely filled by the egg-cluster.

Each egg is attached to the leaf by a slender stem of about the same length as the longest diameter of the egg (Plate II., Fig. 6). The whole mass is more or less covered with the flocculent secretion from the female.

An individual egg (Plate II., Fig. 6) is ellipsoidal in form, .4 mm. (about one-sixtieth of an inch) in length and half as wide. When it is laid it is light yellow, but before hatching it gradually turns darker. When the development of the young is well advanced, two black dots, the eyes of the embryo, may be distinctly seen opposite the end where the egg is attached. The eggs are laid in succession, and consequently do not all hatch at the same time, a period of about two weeks being required. The young nymphs remain under the body of the mother for a short time before coming out.

The insects of the winter generation are quite different from those of the summer generation, the adult form of which is winged. These may be called the young of the wingless female (Plate I., figs. 1 and 2). Soon after hatching they measure .4 mm. (about one-sixtieth of an inch) in length, and are oval, tapering slightly toward the posterior end. The top of the head and thorax and spots on the top of the abdomen are brown, the remainder of the body is yellowish brown. The body is distinctly annulated. The dorsum of the body is provided with numerous groups of pores, of from two to five openings each (Plate I., Fig. 3). The head and prothorax bear each six of these groups on each side; the five segments next following, three; the sixth, two; and the seventh segment, one on each side. Eyes small, black, situated on the sides of the head at the base. The eyes are afterward molted, so that the adult female is blind. The antennæ consist of three segments, of which the first two are of nearly equal length, while the third is much longer and irregularly ringed. The tarsus consists of a single segment, and is ringed similar to the terminal segment of the antennæ and provided with digitules. The sucking mouth parts are large and prominent. The setæ, four in number, are very long, and are disposed of by being doubled on themselves and coiled up in the body, only the part in use being protruded. The bristles may be protruded but a very short distance, or they may be extended five times the length of the body. I have watched

an insect under a microscope, with these setæ nearly fully extended, slowly draw them back till all but the very tips disappeared within the body.

After hatching, the young females spread over the limb near by, some attaching themselves to the leaves and some crawling into the crevices at the axils of the leaves and at the base of the buds (Plate I., Fig. 10). None except those at the base of the buds survive the winter, and many thus protected are found dead in the spring. At first the insects are almost invisible, because of their small size, but as winter approaches they secrete from the pores in the back a coating of coarse white threads, which renders them more easily recognized. Before this time, however, all except those at the base of the buds have died and been brushed off.

On coming to rest, the young insect inserts its mouth parts and begins feeding, its size being increased but very little before cold weather sets in and stops its growth. In the spring the old winter coat is molted, and in its place the insect secretes another one of much finer texture. This is explained by the fact that before this molt the groups of pores contained only from two to five openings each, while after molting there are a great many openings. This molt occurs about the third week in April, after which the insect increases in size very rapidly, and secretes a more copious woolly coating. The first eggs were observed May 9. The female, having laid, soon dies, but the woolly mass clings long after the eggs have hatched, even remaining on the tree when the galls have dried up in the autumn.

The Male and Parthenogenesis.

The question whether any male of *Chermes abietis* exists, and, if it does, what it is like, has long been a subject of interest to entomologists. If there is no male, it follows that the females must produce young parthenogenetically; that is, without being fertilized by the male.

Buckton, in his "British Aphides" (Vol. IV., page 31), states that after searching the contents of a number of pseudo-cones he found "a single minute apterous insect, which proved to be the sex long missing." This he describes as measuring 0.030 by 0.015 mm., yellow, blind, apterous; antennæ rudimentary, three-jointed. Rostrum very short. Head broad and joined to the body without the intervention of any well-marked thorax. Abdomen large and deeply ringed. The posterior end is occupied by a remarkably developed male apparatus, which by compression

under weak glycerine gives rise to a plentiful stream of spermatozoa.

Ratzeburg, in the third volume of his "Forst Insecten" (page 200), describes and figures (Plate XII.) what he believed to be a winged male.

During the two years that I have had this insect under observation I have examined a very large number of individuals, and have never found a male of any description. Yet I will not state, with Leuckart, that there is no male. It should be borne in mind that in some of the lower Homopterous insects the male is found with the female in some localities, while in others the females exist and reproduce without males (parthenogenetically).

As to the form described by Buckton as the male of this species, may it not be that it was a molted skin, distended by the liquid secretions of the nymph, as described in a previous paragraph of this paper?

Prof. N. A. Cholodkowski of St. Petersburg, who has been studying this and other species of the genus for several years, states, in the "Zoölogischer Anzeiger" for January, 1896 (page 37), that "*Chermes abietis* is therefore without doubt a clearly parthenoegnetic species." This conclusion he bases chiefly on the fact that *Chermes abietis* completes its life cycle in a single year, and therefore lacks the generation of males and females which in other species of the genus appear in the second year of the cycle.

In further consideration of this question, I would say that to determine this point I took a number of fully developed nymphs and placed one each on a small branch of spruce and enclosed them separately in small cages in the insectary, thus keeping them from all possible contact with males. These nymphs molted to winged imagoes, which laid eggs as usual, and these eggs hatched in due season.

Species of Spruce attacked.

Chermes abietis has been taken on the following species of spruce: white spruce (*Picea alba*), black spruce (*Picea nigra*), Norway spruce (*Picea excelsa*), hemlock spruce (*Picea canadensis*) and blue spruce (*Picea pungeus*). Small trees in nurseries and trees recently transplanted, or trees otherwise weakened by frost or animals, are more frequently attacked than others.

Physiological Botany of the Gall.

The fact that this insect by its own operations is able to cause a young twig to develop into such an abnormal form is very interesting. Physiological botany teaches that all such growths as galls

caused by insects, and callouses which grow over wounds inflicted on trees, are the result of what is known as stimulation. The stimulation or irritation in this case is the puncture of the setæ of the hibernating female into the bud, as previously described. Botanists agree that stimulation of this nature sets up a division of the plant cells. Each cell divides in the middle, producing two, which after reaching full size divide as did the parent cell, thus producing four. As this goes on, a swelling is naturally produced, and this swelling is the gall. It is not necessary that the insect should sting or poison the plant; the piercing of the setæ is sufficient cause for the formation of the gall. Essentially the same thing occurs when the limb of a tree is sawed off. The inner bark, the growing part of the tree, is injured or stimulated, and the cell division begins, causing a swelling or callous, which gradually grows over the end of the limb. Why the gall should take on its characteristic form and color has not been explained.

As a result of the stimulation, there may be in addition to the cell divisions a deposition of material in the cells, as starch, proteids, resin, etc., which appear as minute granules of definite character. The plant cells of the gall produced by the insect are abnormally large, with thin walls, and contain more starch than those of the unaffected parts of the same stem. It may be that this starch is the food on which the young lice subsist.

Explanation of Plate I.

Drawn by R. A. Cooley.

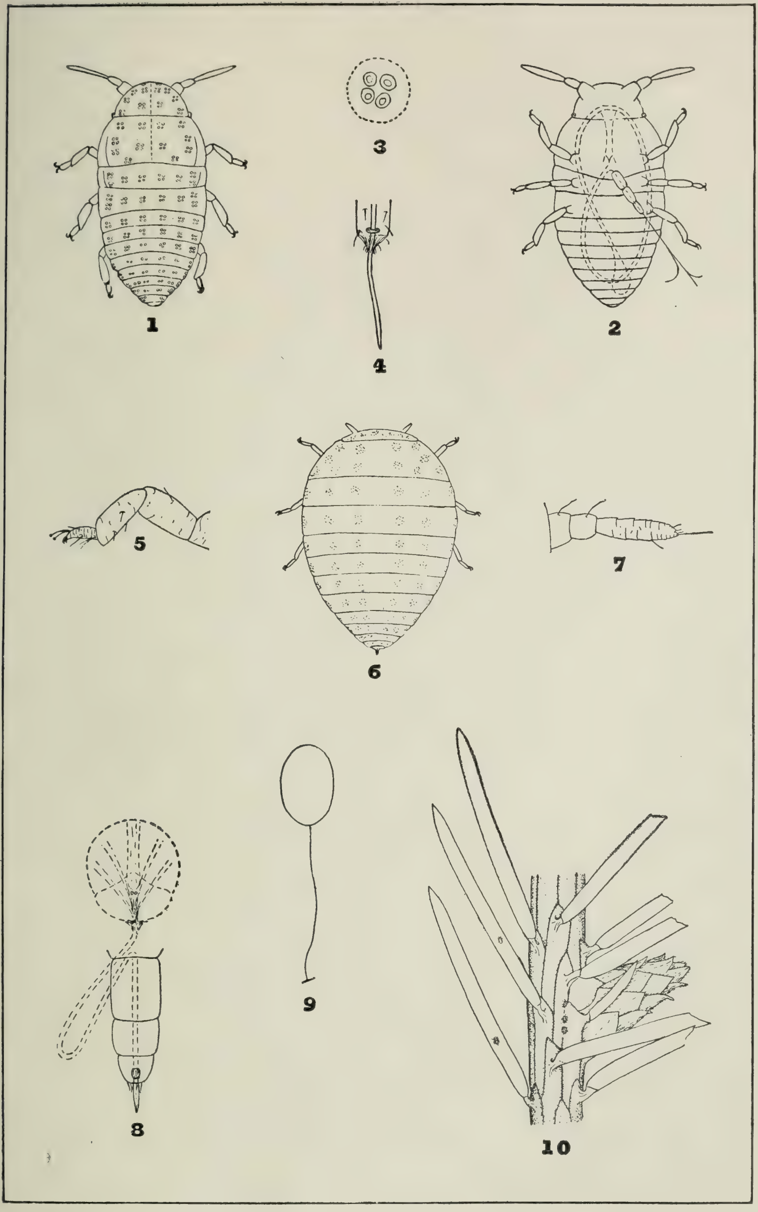
1. Top view of young female of the winter generation, enlarged.
2. Under view of same, enlarged.
3. A group of pores from the back of the young female of the winter generation, greatly enlarged.
4. End of the mouth parts of female of the winter generation, greatly enlarged.
5. Leg of the young female of the winter generation, greatly enlarged.
6. Top view of the denuded body of the adult female of the winter generation, enlarged.
7. Antenna of the adult female of the winter generation, greatly enlarged.
8. Mouth parts of the adult insect of the summer generation, showing the origin of the four setæ in the buccal cavity, greatly enlarged. Broken lines are internal, full lines are external.
9. An egg laid by the female of the winter generation, greatly enlarged.
10. Section of a spruce twig, showing the insects of the winter generation as they are in the fall, slightly enlarged.

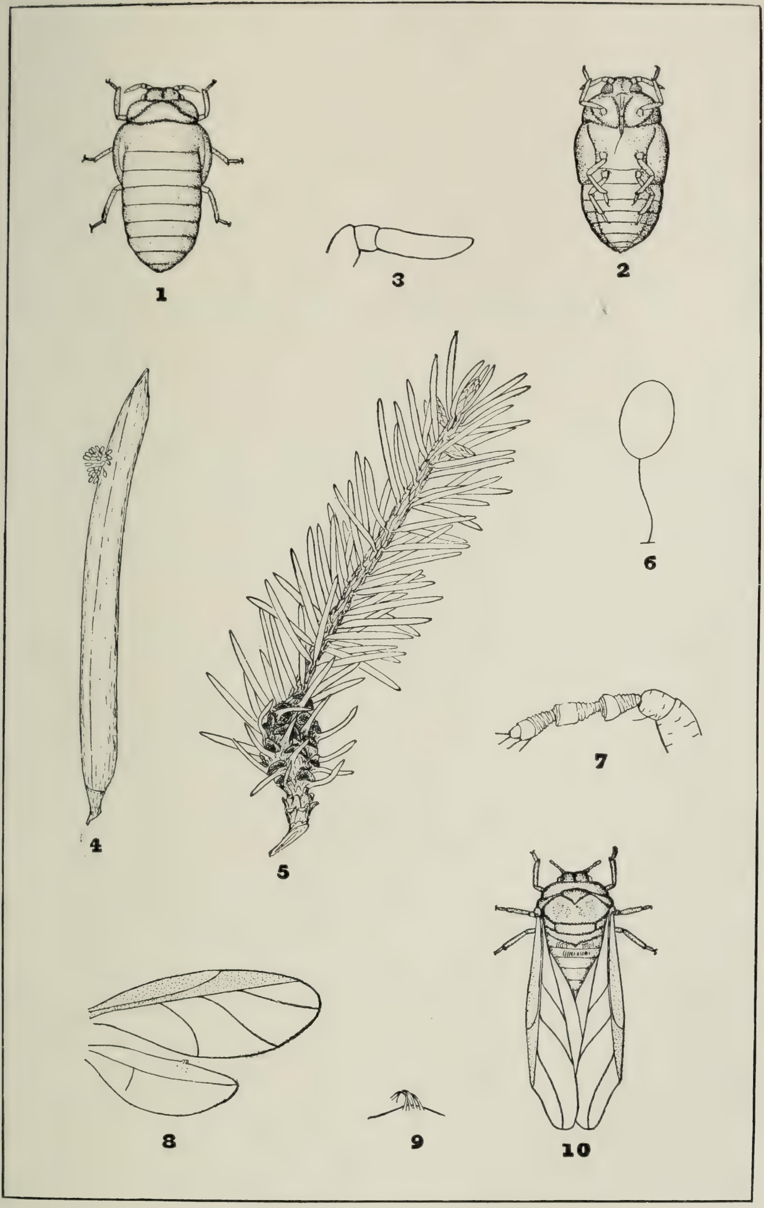
Explanation of Plate II.

Drawn by R. A. Cooley.

1. Top view of the nymph of the summer generation, enlarged.
2. Under view of the same, enlarged.
3. Antenna of nymph of the summer generation, greatly enlarged.
4. A cluster of eggs on a spruce needle, laid by the female of the summer generation, enlarged.
5. A spruce twig, with a vacated gall at the base.
6. An egg laid by the female of the summer generation, greatly enlarged.
7. Antenna of the adult female of the summer generation, greatly enlarged.
8. Fore and hind wing of female of the summer generation, enlarged.
9. Hooklets from the costa of the hind wing, in figure 8, greatly enlarged.
10. Top view of the adult female of the summer generation, enlarged.

Plate I.

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NINTH ANNUAL REPORT

OF THE

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

JANUARY, 1897.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated, under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are: —

Henry H. Goodell, LL.D.,	*Director.*
William P. Brooks, B.Sc.,	*Agriculturist.*
George E. Stone, Ph.D.,	*Botanist.*
Charles A. Goessmann, Ph.D., LLD.,	*Chemist* (fertilizers).
Joseph B. Lindsey, Ph.D.,	*Chemist* (foods and feeding).
Charles H. Fernald, Ph.D.,	*Entomologist.*
Samuel T. Maynard, B.Sc.,	*Horticulturist.*
Leonard Metcalf, B.S.,	*Meteorologist.*
Henry M. Thomson, B.Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B.Sc.,	*Assistant Botanist.*
Henri D. Haskins, B.Sc.,	*Assistant Chemist* (fertilizers).
Robert H. Smith, B.Sc.,	*Assistant Chemist* (fertilizers).
Edward B. Holland, B.Sc.,	*Assistant Chemist* (foods and feeding).
Robert A. Cooley, B.Sc.,	*Assistant Entomologist.*
Joseph H. Putnam, B.Sc,	*Assistant Horticulturist.*
Benjamin K. Jones, B.Sc.,	*Assistant in Foods and Feeding.*

The co-operation and assistance of farmers, fruit growers, horticulturists and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the "Hatch Experiment Station, Amherst, Mass."

Bulletins issued, 1887–97.

No. 1. Protection of peach buds; effect of girdling; jumping sumac beetle.

No. 2. Grape-vine leaf hoppers; ants; poisonous doses of insecticides, and treatment; report on standard varieties of fruit.

No. 3. Bovine tuberculosis.

No. 4. Steam heat *v.* hot water for heating greenhouses; evaporated sulphur as an insecticide; plant diseases.

No. 5. Buffalo carpet beetle; larder beetle; clothes moth.

No. 6. Steam *v.* hot water; fungous diseases of plants.

No. 7. Tests of small fruits and vegetables; girdling; protection of fruit trees from animals; Japanese millets and beans; the gypsy moth.

No. 8. Steam *v.* hot water; peach yellows; danger from the use of milk coming from tuberculous cows.

No. 9. Soil tests.

No. 10. Special fertilizers for greenhouse crops; report on small fruits.

No. 11. Strength of rennet; hay caps; potato rot; fungicides and insecticides for fruit.

No. 12. Bud moth; spittle insects; squash bug; pea and bean weevil; May beetle; curculio; onion maggot; cabbage butterfly; tent caterpillar; forest tent caterpillar; stalk borer; pyramidal grape-vine caterpillar; grape-berry moth; codling moth; cabbage-leaf miner; gartered plume moth.

No. 13. Directions for using fungicides and insecticides.

No. 14. Fertilizers for corn.

No. 15. Over-bench *v.* under-bench heating; special fertilizers for plants under glass; varieties of strawberries, blackberries, raspberries.

No. 16. Summary of results in electro-culture.

No. 17. Fungicides and insecticides; varieties of grapes and peaches; protection of peach buds; copper on sprayed fruit; Siberian crab as a stock; girdling grape vines; spraying apparatus.

No. 18. Fertilizers for potatoes, oats and corn; muriate of potash; corn and millet as grain crops; report on oats, hemp, flax, English wheats, Japanese millets and beans.

No. 19. Gypsy moth; effect of Paris green on foliage; Barnard's insect trap; lice and spiders on rose bushes; kerosene emulsion; effects of Paris green on tent caterpillars; cranberry insects.

No. 20. Canker worms; tent caterpillar; fall web worm; tussock moths.

No. 21. Bordeaux mixture; ammoniacal carbonate of ammonia; copper sulphate; fruits.

No. 22. Small fruits.

No. 23. Electro-culture.

No. 24. Arsenate of lead; Paris green and lime; Jamestown weed; horn fly.

No. 25. Fungicides and insecticides; grape tests.

No. 26. Strawberries; blackberries; raspberries.

No. 27. Tuberculosis in college herd; tuberculin in diagnosis; bovine rabies; poisoning by nitrate of soda.

No. 28. Canker, army and corn worms; red-humped apple-tree caterpillar; antiopa butterfly; currant stem girdler; imported elm-bark louse; greenhouse orthezia.

No. 29. Fungicides and insecticides; new spraying pump; spraying calendar.

No. 30. Fertilizer analyses.

No. 31. Fertilizer analyses.

No. 32. Fertilizer analyses.

No. 33. Glossary of fodder terms.

No. 34. Fertilizer analyses; analyses of manurial substances.

No. 35. Agricultural value of bone meal.

No. 36. Imported elm-leaf beetle; maple pseudococcus; abbot sphinx; San José scale.

No. 37. Report on fruits, insecticides and fungicides.

No. 38. Fertilizer analyses; composition of Paris green; action of muriate of potash on the lime resources of the soil.

No. 39. Economic feeding of milch cows.

No. 40. Fertilizer analyses.

No. 41. On the use of tuberculin (translated from Dr. Bang).

No. 42. Fertilizer analyses; fertilizer laws.

No. 43. Effects of electricity on germination of seeds.

Special Bulletins.

Index, 1888 to 1895.
Gypsy moth.
The most profitable use of commercial fertilizers (translated from Paul Wagner).
The true value of green manuring (translated from Julius Kuehn).

Of the above bulletins, the edition of No. 2 is entirely exhausted; Nos. 1, 3–24 inclusive, 26, 30–32 inclusive and 34 are nearly exhausted, a few copies of each remaining, which can only be supplied to complete sets for libraries; Nos. 25, 27–29 inclusive, 33, 35–43 inclusive, and the index number are still in stock.

ANNUAL REPORT

Of George F. Mills, *Treasurer pro tem.*, of the Hatch Experiment Station of Massachusetts Agricultural College,

For the Year ending June 30, 1896.

Cash received from United States treasurer,		$15,000 00
Cash paid for salaries,	$5,218 50	
for labor,	3,541 94	
for publications,	2,816 86	
for postage and stationery,	284 66	
for freight and express,	185 60	
for heat, light and water,	110 15	
for seeds, plants and sundry supplies,	572 98	
for fertilizers,	96 88	
for feeding stuffs,	291 51	
for library,	686 83	
for tools, implements and machinery,	326 63	
for furniture and fixtures,	70 47	
for scientific apparatus,	96 00	
for travelling expenses,	92 31	
for contingent expenses,	155 11	
for building and repairs,	453 57	
		$15,000 00
On hand July 1, 1895: —		
Received from Dr. Goessmann,	$1,704 37	
from State treasurer,	10,000 00	
from fertilizer fees,	3,627 17	
from farm products,	1,204 46	
from miscellaneous,	733 64	
		$17,269 64
Cash paid for salaries,	$9,502 66	
for labor,	434 02	
for publications,	115 37	
for postage and stationery,	186 64	
for freight and express,	127 77	
Amounts carried forward,	$10,366 46	$17,269 64

Amounts brought forward,	$10,366 46	$17,269 64
Cash paid for heat, light and water,	287 31	
for chemical supplies,	901 98	
for seeds, plants and sundry supplies,	475 34	
for fertilizers,	825 01	
for feeding stuffs,	484 58	
for library,	332 86	
for tools, implements and machinery,	15 15	
for furniture and fixtures,	311 98	
for scientific apparatus,	15 50	
for live stock,	365 00	
for travelling expenses,	17 19	
for contingent expenses,	491 66	
for building and repairs,	1,336 70	
Balance,	1,042 92	
		$17,269 64

AMHERST, MASS., Aug. 31, 1896.

I, Charles A. Gleason, duly appointed auditor of the corporation, do hereby certify that I have examined the books and accounts of the Hatch Experiment Station of the Massachusetts Agricultural College for the fiscal year ending June 30, 1896; that I have found the books well kept and the accounts correctly classified as above, and that the receipts for the year are shown to be $32,269.64 and the corresponding disbursements $31,226.72. All the proper vouchers are on file, and have been by me examined and found to be correct, there being a balance of $1,042.92 on accounts of the fiscal year ending June 30, 1896.

CHARLES A. GLEASON,
Auditor.

REPORT OF THE AGRICULTURIST.

WILLIAM P. BROOKS.

Leading Results and Conclusions based upon the Experiments outlined in the Report of the Agriculturist.

Cabbages and Swedes.

1. Soil-test work indicates that fertilizers for these crops should be particularly rich in available phosphoric acid and potash.

2. The muriate of potash has been found a useful form in which to supply the potash.

3. The material used to supply phosphoric acid in our experiment was dissolved bone-black, but it is believed that other available phosphoric acid fertilizers will be found equally serviceable.

Soy Beans.

1. Soil-test work shows a very intimate connection between potash supply and the growth of this crop.

2. The form in which potash has been supplied in soil tests is the muriate, but other experiments indicate that the sulphate is superior to this salt for beans.

Corn.

Soil Test with Corn. — A carefully conducted soil test with corn in Norwell, Plymouth County, upon somewhat exhausted soil, previously for many years in grass, shows potash to be here the controlling element for this crop, as in so many other places.

Hill v. Drill Culture of Corn. — Experiments continued in different fields from five to six years indicate that corn planted in drills will usually produce larger crops than when planted in hills. This increase is most marked, as might be expected, in case of the stover, but applies to the grain as well.

Green Manuring in Continuous Corn Culture.

1. *White mustard*, sown in standing corn at the time of the last cultivation, helps to keep down weeds, furnishes useful pasturage for sheep or young stock, conserves soil nitrogen, does not decrease the yield of corn the year it is sown, and can be counted upon to improve the soil if turned under. *It also helps largely to prevent soil washing in winter.*

2. *Crimson and sweet clovers* have not proved to be suited for green manuring crops in continuous corn culture, since they are not sufficiently hardy.

Variety Tests.

Potatoes.

1. Of 60 varieties of potatoes cultivated, but 5 showed themselves to be in any marked degree superior as crop producers to the Early Rose and Beauty of Hebron.

2. These, with rates of yield per acre in bushels, are as follows: Carman No. 1, merchantable, 355.3; small, 28.6. Fillbasket, merchantable, 336; small, 24.5. New Satisfaction, merchantable, 306; small, 25.7. Early Maine, merchantable, 305.1; small, 35.6. Dutton's Seedling, merchantable, 304.5; small, 19.8.

3. The Early Rose yielded: merchantable, 292.8; small, 21 bushels. The Beauty of Hebron (somewhat injured by proximity to other crops), merchantable, 275.9; small, 18.7 bushels.

4. The varieties tested showed no very marked differences in respect to ability to resist blight.

Corn.

1. Of 21 varieties of Flint corn cultivated, 7, or 33⅓ per cent., gave a yield at the rate of 83⅓ bushels per acre or over.

2. Of 46 varieties of Dent corn, 13, or 28 per cent., equalled or exceeded the same rate of production.

3. Among the best of the Flint varieties are the White Flint,* Sanford,* Compton's Early, Giant Long White and Longfellow.

4. Among the best Dent varieties as indicated by our trial are Yellow Rose, Mastodon, Reed's Yellow Dent, New Golden Triumph and Leaming; but Sibley's Pride of the North, though standing ninth in weight of ears produced, matured among the earliest, and is undoubtedly one of the best Dent varieties for grain production.

Clovers.

1. Crimson clover can be grown as an annual, and gives one good crop; but it will not usually survive our winters, and does not, therefore, at present appear to be worthy of attention as a fodder crop.

2. The mammoth clover exceeds the common red in productive capacity, having produced more hay in two cuttings than the common red in three. It is especially to be commended for sowing with timothy.

3. Alsike clover appears not to be as long lived as the mammoth and the common red.

Millets.

1. For seed production the Japanese "barn-yard" and the Japanese "common" again show their superiority, producing respectively 57 and 53.3 bushels per acre.

2. As a result of a careful comparison of 17 varieties, the Japanese white-seeded panicle millet and the Japanese barn-yard millet are found to lead all other varieties in productive capacity.

* These two are apparently nearly or quite identical.

New Crops.

The flat pea (*Lathyrus sylvestris*) has not been found to be of value as a fodder crop.

The horse bean (*Vicia faba*) has not been found to do well.

Sorghum of different varieties appears inferior to Indian corn as a fodder crop.

Saccaline is found not to be hardy and will probably not prove of value as a fodder crop.

Miscellaneous.

Fungiroid has not been found effective in preventing potato blight.

Sulphur applied in the drill did not prevent scab of potatoes.

The Symmes' hay cap is preferred to cloth caps.

Soil Tests.

Soil tests, upon the plan outlined in previous reports, have been carried on upon a somewhat less extensive scale. We have had four such experiments this year: one with soy beans and one with turnips and cabbages upon our own grounds; and one in Montague and another in Norwell, with corn. Circumstances compelled the cessation of the work in Concord, Worcester and Shelburne, and it was not considered important to continue it longer in Hadley, as this town lies so near Amherst, and as the soil upon which we were working gave results so entirely similar to those obtained upon our own. The main conclusions justified by the results of the past season are as follows: —

1. Potash is the controlling element in the case of the corn crop in Norwell.

2. Nitrogen appears to have been the most useful element for the corn crop in Montague; but the results are obscured in a measure by differences in natural fertility in different parts of the field.

3. A combination of potash and phosphoric acid appears to be necessary to materially increase either the cabbage or the turnip crops in Amherst.

4. Potash proves much the most useful single element for the soy-bean crop in Amherst.

1. *Soil Tests with Corn.*

In Montague the experiment was carried out upon land belonging to Mr. H. M. Lyman, and is the first year this land has been used in such work. The field selected is level, and it was thought it would be suited for the purpose, though it had been more recently manured than we would have liked. The results show that it was not as even in fertility as is desirable. The yields of the five scattered nothing plats were respectively at the rates of 12, 10.5, 19, 32 and 19.9 bushels per acre. Under such conditions, we are not justified in attempting to draw general conclusions. The nitrate of soda appears to have produced an average increase at the rate of: grain, 11 bushels; stover, 158.5 pounds per acre. The average effect of the phosphate appears to have been a decrease in both grain and stover, while the potash appears to have increased the stover slightly but not the grain.

In Norwell the experiment was carried out upon land belonging to the writer, and is the first year this land has been used in such work. The field was in grass in 1895, and is in rather a low state of fertility. Throughout the season potash seemed to be the controlling element. At the time of harvesting, plat 5, receiving muriate of potash alone at the rate of 160 pounds per acre, appeared to be as heavy as either plats 10 or 13, receiving respectively complete fertilizer and stable manure. Owing to a slight accident at the time of harvesting, figures cannot be published at this time.

2. *Soil Test with Cabbages.*

This test occupied one-half of the land which has been designated the "north acre" in previous reports, the other half being occupied with Swedish turnips. The acre was

divided by a line running through the middle across the plats, the one end being devoted to cabbages, the other to turnips.

This acre had been for five years devoted to soil-test work, the crops in order of succession having been corn, potatoes, soy beans, grass and clover, and grass and clover. During this time the nothing plats have received no manure or fertilizer of any kind. The variety of cabbages raised was Fottler's Drumhead. The seed was planted in the field. The average yield of the nothing plats was at the rate of 2,470 pounds of hard and 7,190 pounds of soft cabbages per acre.

The average result of the application of phosphoric acid was an increase at the rate per acre: hard heads, 9,557.5 pounds; soft heads, 1,912.5 pounds, — a profit from the use of phosphate amounting to $23.08 per acre. The use of the phosphate without potash, however, had practically no effect upon the crop.

The average increase apparently due to the potash is at the rate per acre: hard heads, 10,147.5 pounds; while there is an average decrease in soft heads at the rate of 527.5 pounds per acre. The net average result of the use of potash is profit at the rate of $21.51 per acre. The potash, even without the phosphoric acid, produces a considerable increase, but produces two and one-half times as great an increase in combination with a phosphate.

The nitrogen is much less useful. The average is at the rate of 2,627.5 pounds increase in hard heads and 402.5 pounds decrease in soft heads, per acre. It produces the largest increase when used with phosphate. The net result of the use of nitrate of soda is a gain at the rate of $6.07 per acre.

The results are not as clear in their indications as could be wished, though they point to a close dependence of this crop upon both potash and phosphoric acid manuring. The experiment will be repeated when opportunity offers.

3. Soil Test with Swedish Turnips.

This crop, as stated above, occupied one-half of the acre on which the test with cabbages was carried out. The variety was Laing's Swedish turnip, sown June 13. The results show a close agreement with those obtained with the cabbages. The average of the nothing plats was at the rate of 10,250 pounds per acre.

The average result of the use of phosphoric acid (dissolved bone-black) was an increase at the rate of 6,308.5 pounds per acre. Similar averages for the potash (muriate) and nitrogen (nitrate of soda) were, respectively, 7,255 and 2,891.7 pounds. The net average profits are at the rates per acre: for the phosphoric acid, $9.42; for the potash, $11.35; and for the nitrate, $2.58.

Here, as with the cabbages, the combination of phosphoric acid and potash seems essential to large increase in the crop. The phosphoric acid without potash gives no increase; with potash alone, an increase at the rate of 11,700 pounds per acre. The potash alone gives an increase of but 400 pounds per acre, but with the phosphate it gives an increase of 13,633 pounds per acre.

The combination of phosphate and potash gives an increase at the rate of 12,100 pounds per acre, as compared with the nothing plats nearest to the one on which it was used.

4. Soil Test with Soy Beans, Amherst, South Acre.

This is the eighth season of soil-test work upon this acre. The beans, variety Medium Green, were sown May 19, in drills 2½ feet apart, requiring 25 pounds seed for the acre. The nothing plats produced an average of 350 pounds beans and 757½ pounds straw per acre.

Potash (muriate) appears to be the most useful element, giving an average increase per acre of 646⅔ pounds beans and 451⅔ pounds straw. The average increase per acre caused by phosphoric acid (dissolved bone-black) was 126⅔ pounds beans and 250 pounds straw. Similar average for nitrogen (nitrate of soda) was 13½ pounds beans and 116⅔ pounds

straw. Nitrogen produced a decrease, except when used with both phosphoric acid and potash.

In appearance the beans grown upon potash were larger and plumper than those grown upon either phosphoric acid or nitrogen.

Manuring the Corn Crop.

1. Manure alone v. Manure and Potash.

The past is the sixth year of continuous culture of corn upon the same acre of land for the purpose of testing the relative value of an application yearly of a small quantity of *manure* with *muriate of potash*, as compared with a larger application of *manure alone*. When manure alone was applied, it was put on at the rate of 6 cords per acre, being spread broadcast after ploughing, and harrowed in. The manure and potash similarly applied have been put on at the rate of 4 cords of the former and 160 pounds of muriate of potash for the latter.

The plats, four in number, contain one-quarter of an acre each. The results are shown below: —

Plat 1, manure, 8,115 pounds: stover, 1,600 pounds; ear corn, 1,530 pounds.

Plat 2, manure, 5,354 pounds; muriate of potash, 40 pounds: stover, 1,300 pounds; ear corn, 1,455 pounds.

Plat 3, manure, 8,981 pounds: stover, 1,255 pounds; ear corn, 1,450 pounds.

Plat 4, manure, 5,711 pounds; muriate of potash, 40 pounds: stover, 970 pounds; ear corn, 1,120 pounds.

In plats 3 and 4 the corn was planted in hills, while in 1 and 2 it was planted in drills. This no doubt accounts in a measure for the considerable difference in yield. The inferiority of the crop from plat 4 is due to the fact that, from force of circumstances, poorer manure was used upon it in 1895 than upon the other plats.

Averaging the results upon 1 and 3 and upon 2 and 4, we find the yields have been at the following rates per acre: —

With manure alone: stover, 5,710 pounds; grain, 73¼ bushels.

With manure and potash: stover, 4,540 pounds; grain, 64⅝ bushels.

In no one of the six years during which this experiment has been continued has the crop raised on the combination of manure with potash equalled that raised on a larger quantity of manure alone; but the differences have been small, and in no case has the value of the excess in crop produced by the larger quantity of manure been sufficient to cover the excess in cost of the manure applied. The difference in crop is this year considerably larger than in any preceding year; and, as this difference has been quite steadily increasing, we are justified in concluding that the manure and potash in the quantities employed cannot fully take the place of the larger application of manure in continuous corn culture. It is true the crop where the manure and potash are employed is still an excellent one, averaging for the two plats at the rate of more than 63 bushels per acre. Continuous corn culture is not, however, the rule, nor indeed under most circumstances advisable, though often proved to be possible, at least for many years; and therefore this land has now been seeded to grass and clover, for the purpose of determining to what extent, if any, the introduction of these crops will enable the farmer under the given manuring to secure equal crops with both systems.

2. *Special Corn Fertilizer v. Fertilizer containing More Potash.*

This experiment in continuous corn culture was begun in 1891, and the present is, therefore, the sixth season. The object in view is a comparison of the results obtained with a fertilizer proportioned like the average of the "*special*" *corn fertilizers* found upon our markets in 1891 with those obtained with a fertilizer richer in potash but furnishing less nitrogen and phosphoric acid. The results in previous years have indicated the financial advantage to lie with the latter fertilizer.

Four plats of one-fourth of an acre each are devoted to this experiment, which are respectively numbered 1, 2, 3 and 4.

The materials applied to the several plats are shown below: —

FERTILIZERS.	Plats 1 and 3 (Pounds Each).	Plats 2 and 4 (Pounds Each).
Nitrate of soda, ...	20	18
Dried blood, ...	30	30
Dry ground fish, ...	30	20
Plain superphosphate, ...	226	120
Muriate of potash, ...	22.5	60
Cost of materials per plat, ...	$3 23	$3 10

The materials supplied to plats 1 and 3 would furnish per acre the quantities of nitrogen, phosphoric acid and potash found in 1,200 pounds of fertilizer having the average composition of the "special" corn fertilizers upon the market at the time the experiment was commenced, viz., 1891. The average price per plat for 300 pounds of such fertilizer (the amount needed per plat to equal the above materials) is about $5.25.

The yields the past year are shown below: —

Plat 1, "special" fertilizer: stover, 935 pounds; ear corn, 1,110 pounds.
Plat 2, fertilizer richer in potash: stover, 995 pounds; ear corn, 1,030 pounds.
Plat 3, "special" fertilizer: stover, 790 pounds; ear corn, 1,135 pounds.
Plat 4, fertilizer richer in potash: stover, 865 pounds; ear corn, 1,065 pounds.

Computed to the acre and the grain in bushels, the averages are: "special," stover, 3,450 pounds; grain, 56.1 bushels; fertilizer richer in potash, stover, 3,720 pounds; grain, 52.4 bushels. It will be noticed that the "special" fertilizer gives rather more grain and less stover than the fertilizer richer in potash. This result is in entire accord with the results of previous years, and the indications are strong, therefore, that our mixture "richer in potash" needs modification to make it equal in grain-producing power to the "special" fertilizer for *continuous corn culture.* It is

still my belief, however, that under ordinary farm conditions the "*fertilizer richer in potash*" would be found equal at least to the "special," for under such conditions grass and clover would alternate with the corn; the clover, judging from facts almost universally noticed, would thrive better where more potash had been used, and as a result the soil would be enriched in nitrogen, which would be favorable to the development of the succeeding corn crop. In all of our "soil-test" work the nitrogen has ranked next to the potash in benefit to this crop. With a view to testing the correctness of this conclusion, the land used for this experiment has now been seeded to grass and clover, and after two or three years will again be planted with corn.

The average crop raised on the "special" fertilizer this year is worth \$0.83 more per acre than the average for the fertilizer richer in potash; the fertilizer materials used cost \$0.52 more. There is no material difference, therefore, in the financial outcome of the two systems under the given conditions; but, as above pointed out, should the farmer purchase a manufactured "*special*" *corn fertilizer*, it would have cost him about \$5.25 per plat, or \$21 per acre, to procure equal amounts of the essential elements of plant food. Since the "*fertilizer richer in potash*" cost \$3.10 per plat, or \$12.40 per acre, while the crop was practically almost as valuable as that produced on the "special," it follows that here is a possible saving of almost \$8 per acre in initial expenditure. It is true that the materials recommended require mixing, while the "special" fertilizer is already mixed. It is not true that the elements of plant food in the "special" are in better forms, or more available. In conclusion, however, it is but fair to state that the prices used in calculating the cost of the "*materials*" are cash prices, while the price of the "special" is determined in a measure by the fact that credit must often be given for such goods.

Hill v. Drill Culture for Corn.

In each of the two experiments above described one-half of each acre has each year been planted in drills and the other half in hills. Plats 1 and 2 in each case have been

planted in drills, and plats 3 and 4 in hills. The distance between the rows under both systems has been $3\frac{1}{2}$ feet. Under the "drill" system, the plants have been thinned to 1 foot; under the "hill" system, the hills are 3 feet apart and the plants are thinned to three in a hill. We thus have equal numbers of plants under the two systems. The results the past year average as follows: for the acre receiving manure, drill culture, at rate per acre, stover, 5,800 pounds; grain, $74\frac{5}{8}$ bushels; hill culture, at rate per acre, stover, 4,450 pounds; grain, 63 bushels; for the acre receiving fertilizer similar averages are, drill culture, stover, 3,630 pounds; grain, $53\frac{7}{8}$ bushels; hill culture, stover, 3,540 pounds; grain, $54\frac{5}{8}$ bushels. Averaging both experiments, we have, for drill culture, stover, 4,715 pounds; grain, $64\frac{1}{4}$ bushels; for hill culture, stover, 3,995 pounds; grain, $58.\frac{4}{5}$ bushels.

Green Manuring in Continuous Corn Culture.

White mustard as a crop for green manuring and nitrogen conservation was sown on one-half the acre where *manure alone* has been under comparison with *manure and potash* in each of the years from 1892 to 1894 inclusive, the seed being scattered in the standing corn late in July in each year. The growth varied greatly from year to year, but the practice proved beneficial. In 1895 the increase in the corn crop apparently due to the culture of the mustard amounted to: stover, 452 pounds; grain, 5.4 bushels. In July, 1895, the mustard was sown only on one-quarter of the acre, and, because of a very dry and hot autumn, the growth was light. The crop on this quarter this year shows an increase as compared with the quarter not so treated of: stover, 680 pounds; grain, 3 bushels, per acre.

The other plat, which had been sown with mustard in preceding years, was in 1895 sown with rye on September 5, at the rate of 3 bushels per acre. The growth was good, and the rye, when ploughed in on May 11, was 18 inches tall. The apparent result of this treatment is a decrease in crop at the rate per acre: stover, 700 pounds; grain, $4\frac{3}{4}$ bushels. It seems impossible to believe that the effect of this treatment can be permanently injurious. The decrease

in yield this year may be due to the fact that considerable available plant food which was locked up in the rye has not yet by the decay of the vegetable matter of this crop become again available. If this be the true explanation, then in the next year the beneficial effect of the green manuring should become apparent.

On the acre where "*special*" *corn fertilizer* has been under comparison with *fertilizer richer in potash* some crop of *the clover family* has been sown in the standing corn each year since 1893; but the crops themselves have been under trial, and have not shown themselves fitted for the purpose in view. Thus, in 1893 and 1894 *crimson clover* was tried, but each following spring the crop was killed and the results were unimportant. In July, 1895, *sweet clover* (*Melilotus alba*) was sown upon one quarter and common *red clover* upon another. The *sweet clover* was badly thrown out by the frost, and hardly a plant survived; while the red clover starts too late in spring to have made much growth before it must be turned in. The results are unimportant in both cases, though the crop this year is somewhat greater where the red clover was sown, viz., at the rate of 55.25 bushels per acre, against 52.75 bushels where no clover was sown.

Variety Tests.

1. *Potatoes.*

In the spring of 1895 we procured as far as possible seed of all prominent and new varieties of potatoes, necessarily from widely scattered and very different sources. This seed was planted for the purpose of raising under like conditions a stock of the different sorts, which, having been produced under identical conditions and in every respect handled alike, it was thought would be suited for a comparative test of varieties. Sixty varieties, the seed of which (in every instance save one) was raised upon our own grounds last season, have been made the subject of such a comparative trial this year. The variety the seed of which was from another source is Carman No. 1. Our seed of this sort raised last year was accidentally destroyed, and, as the variety is a prominent one, it was thought best to pro-

cure enough for this trial from a prominent grower in this State, Dr. Jabez Fisher of Fitchburg. Of most varieties we planted 2 rows, each 209 feet long; but in some cases, where the seed was insufficient, only 1 row was planted.

The seed was washed and treated with a solution (2 ounces to 15 gallons of water) of corrosive sublimate on April 13. The tubers were then placed on the earth in a cold frame without glass, where they were allowed to remain until May 1, when they were cut into pieces having two eyes each, and of as nearly equal size as possible. At this time the tubers had sent out numerous thick green sprouts, which were perhaps about one-eighth to one-fourth of an inch in length. The tubers when cut were rolled in plaster. They were planted on May 5 and 6, the pieces being placed just 1 foot apart in the rows. In those cases where the supply of seed was insufficient to plant a full row, the row was filled out with seed of the Beauty of Hebron, that there might be no vacancies.

The treatment of the seed with corrosive sublimate solution entirely prevented scab, and the system followed in sprouting the tubers was eminently satisfactory. It should perhaps be stated that when the sun shone hot the tubers were covered with a sheet of thin white cotton cloth. But for this protection it is to be feared that in a cold frame they might get overheated on excessively hot days.

The land where the test was made was last year in millet and soy beans, the rows this year running across the divisions of last season, so that each row of this year is exactly comparable with every other. The soil is a medium loam, well adapted to the potato. Fertilizers only were applied, and at the following rates per acre: nitrate of soda, 240 pounds; dried blood, 100 pounds; tankage, 240 pounds; plain superphosphate, 400 pounds, and high-grade sulphate of potash, 250 pounds. These materials were mixed and strewn in the furrows before the seed was dropped. All needful operations were seasonably and thoroughly carried out. The season was on the whole favorable, so that the crop suffered from no unusual conditions. Careful notes were taken throughout the season, covering all peculiarities in growth and development, time

of blossoming, etc. All varieties suffered somewhat from early blight (*Macrosporium solani*). This was first discovered on 1 variety on July 18. By the 22d it could be detected on 26 other varieties, and by August 3 all except 1 were affected. As early as August 8 the vines of 17 varieties were entirely dead. Between the 8th and 20th the vines of 26 other varieties died, while by August 29 all were dead.

An attempt to prevent this blight by repeated applications of "Fungiroid" was an entire failure. It will be noticed that considerable differences in degree of susceptibility to "blight" showed themselves. Until the varieties have been further tested, however, it is not deemed advisable to publish the details.

The crop was harvested in part on September 10–12, and the balance September 24–25. There was no rot, and the tubers were for the most part smooth and handsome.

The yield has been in every case corrected to 207 hills or sets, so that the results are strictly comparable. The area occupied by this number of hills is almost exactly one-seventieth part of an acre; so that, to bring out the significance of the differences more clearly, I have multiplied the results by seventy, and converted into bushels, thus showing the *rate per acre* yielded by the different sorts.

The varieties are reported in alphabetical order, and for each the tubers are divided into the customary classes, viz., merchantable and small.

Varieties of Potatoes, Yield per Acre (Bushels).

NAME.	Merchantable Tubers.	Small Tubers.
Alexander's Prolific,	123.3	14.0
Alliance,	285.8	42.0
Beauty of Hebron,	275.9	18.7
Bill Nye,	226.3	25.7
Bliss's Triumph,	276.5	25.7
Burbank's Seedling,	207.7	23.3
Burpee's Extra Early,	208.8	49.0
Carman No. 1,	355.3	28.6
Carman No. 3,	199.5	16.9
Chance,	201.8	30.3

Varieties of Potatoes, Yield per Acre (Bushels) — Concluded.

NAME.	Merchantable Tubers.	Small Tubers.
Clarke No. 1,	255.5	26.8
Columbus,	265.4	33.3
Crown Jewel,	169.1	29.2
Dakota Red,	283.5	28.0
Delaware,	235.7	22.2
Dutton's Seedling,	304.5	19.8
Early Essex,	162.2	35.0
Early Harvest,	234.5	44.3
Early Maine,	305.1	35.6
Early Market,	229.9	28.6
Early May,	232.8	22.2
Early Northern,	266.0	42.0
Early Ohio,	159.8	17.5
Early Ohio, Jr.,	232.8	25.1
Early Rose,	292.8	21.0
Early Sunrise,	268.3	32.7
Empire State,	271.3	12.3
Fillbasket,	336.0	24.5
Freeman's,	203.6	30.9
Hampden Beauty,	232.8	27.4
Hampden Chief,	187.8	4.7
Henderson's Early Puritan,	250.8	34.4
Irish Daisy,	172.1	59.1
Late Puritan,	277.1	28.0
Maggie Murphy,	227.5	28.0
Merriman,	266.6	44.9
Monroe Co. Prize,	240.3	31.5
Monroe Co. Seedling,	248.5	21.0
New Ideal,	204.2	8.2
New Queen,	255.5	49.2
New Satisfaction,	306.8	25.7
Onward,	200.7	26.3
Polaris,	149.3	31.5
Pride of the West,	243.8	26.8
Quick Return,	239.8	29.8
Restaurant,	259.0	21.6
Rochester Rose,	272.4	31.5
Rural New Yorker No. 2,	218.8	22.2
Sir William,	282.9	19.8
Six Weeks,	141.8	20.4
Snow Flake,	169.8	32.1
State of Maine,	252.6	34.4
Summit,	246.8	28.6
Sunlit Star,	232.8	41.4
Thorburn,	255.5	31.5
Vanguard,	255.5	30.9
White Elephant,	295.8	23.9
White Star,	235.1	28.0
Woodbury's White,	289.3	26.3
World's Fair,	145.8	26.8

A study of these figures reveals the fact that there are wide differences in yield; but it is noteworthy that the yield of such old standard sorts as the Early Rose and Beauty of Hebron stands far above the average. The yield of the Early Rose is exceeded by but 6 varieties, viz., Carman No. 1, Fillbasket, New Satisfaction, Early Maine, Dutton's Seedling and White Elephant, named in the order of superiority. In addition to these, 6 other varieties, viz., Woodbury's White, Alliance, Dakota Red, Sir William, Late Puritan and Bliss's Triumph slightly exceed the yield of the Beauty of Hebron. In justice to this variety, it is proper to state that it occupied an outside row adjoining land planted to millet, rape and mustard, and was undoubtedly somewhat injured by its proximity to these, as their growth was exceptionally rank. It may well be doubted whether, under precisely equal conditions, the Beauty of Hebron would have been exceeded in yield by a larger number of varieties than was the Early Rose.

The varieties especially noteworthy for large yield in the order of actual production of merchantable tubers, then, with rates per acre in bushels, are the following: Carman No. 1, 355.3; Fillbasket, 336; New Satisfaction, 306.8; Early Maine, 305.1; Dutton's Seedling, 304.5; White Elephant, 295.8; Early Rose, 292.8; Woodbury's White, 289.3; Alliance, 285.8; Dakota Red, 283.5; Sir William, 282.9; Late Puritan, 277.1; Bliss's Triumph, 276.5; and Beauty of Hebron, 275.9. These varieties will all be tested as to eating and keeping qualities.

Seed of 21 other varieties has this season been procured in small amounts from various sources, and the tubers produced from these will be preserved for comparison another season. Ten of these have given a yield at the rate of more than 300 bushels of merchantable tubers per acre, and are therefore very promising.

2. Corn.

Sixty-seven varieties of field corn have been under trial upon a small scale, for the purpose of preliminary observations as to merits and adaptability to different uses; 21 of these were Flint and 46 Dent varieties. Three rows (each

75 feet long) of each variety, with one or two exceptions where not sufficient seed could be obtained, were planted. The trial has involved a large expenditure of time and attention. Notes have been taken from day to day, covering such points as germination, dates of tasselling and silking, height, relative leafiness, time of cutting, etc. The autumn was exceptionally unfavorable to curing of the corn crop; and hence, though an exact record of the weights of product (sound hard ears, soft ears and stover) has been made, it is of less value as a basis for comparative judgment than would ordinarily be the case. Particularly is this true in relation to the stover of the later Dent varieties.

The field used for this trial was in corn last year. The soil is a medium heavy loam, and quite even in quality throughout. *A fertilizer supplying, per acre, nitrate of soda, 72 pounds; dried blood, 120 pounds; dry ground fish, 80 pounds; plain superphosphates, 480 pounds; and muriate of potash, 240 pounds, was applied broadcast after ploughing, and harrowed in.* The rows were uniformly spaced throughout the field, viz., 3½ feet apart. The corn was so planted in checks that when thinned it stood, single plants, at the following intervals in the row: *for all Flint varieties*, 8 inches; for the earlier Dents, 10 inches; and for the later Dents, 12 inches.

Without going into much detail, I have to report further concerning this trial: —

1. That the following pairs of varieties appear to be nearly if not quite identical: —

Champion White Pearl and White Pearl.
Buckbee's No. 7 and Colossal.
White Cap Dent and White Cap Yellow Dent.
Sanford and White Flint.
Rideout and Longfellow.
Dibble's Early Mammoth and Houghton's Silver White Flint.

2. The yield of ear corn all or nearly all of which was sound and well cured varied: for the Flint varieties, between 79 and 130 pounds; for the Dent varieties, between 78 and 144 pounds.

3. Seven out of the 21 Flints gave a yield of 120 pounds* or over; 13 of the 46 Dents gave a similar yield, but with a larger proportion of imperfectly cured ears; 33 per cent. of the Flints and 28 per cent. of the Dents, therefore, come into this class.

4. The yield of stover varied: for the Flint corns, between 104 and 245 pounds; for the Dent corns, between 94 and 451 pounds. Some of the Dents giving high yields of stover were far from perfectly cured.

5. The order of rank in yield of ears of the best 5 Flint varieties was as follows: White Flint, Sanford, Compton's Early, Giant Long White and Longfellow.

6. The best 5 Dent varieties in order of ear production are: Yellow Rose, Mastodon, Reed's Yellow Dent, New Golden Triumph and Leaming.

7. Sibley's Pride of the North, very thoroughly matured, ranks ninth in production of ears, and is undoubtedly one of the best Dent varieties for grain production.

8. The following varieties appear to be unsuited to our locality, on account of being too late: Brazilian, Farmer's Favorite, Queen of the Prairie, Golden Beauty, Golden Dent, Legal Tender, Mammoth White Surprise and Dr. Woodhull.

9. Three other varieties are certainly too late for culture as grain crops, but appear to promise well for the silo, viz., New Golden Triumph, Hickory King and Mastodon.

3. *Clovers.*

Four varieties of clover have been given a thorough comparative trial, viz., mammoth (*Trifolium medium*), common red (*T. pratense*), alsike (*T. hybridum*) and crimson (*T. incarnatum*). The soil of Field B is a medium heavy loam, but thoroughly drained. For some twelve years it has been manured only with ground steamed bone and potash salts. The plats are one-tenth of an acre each in size. Every plat is manured yearly with ground bone, at the rate of 600 pounds to the acre; one-half of these plats receive yearly an

* A yield of 120 pounds corresponds to a product of 83½ bushels shelled grain per acre.

application of muriate of potash at the rate of 200 pounds per acre, and the other half receive the same quantity of high-grade sulphate of potash. The land was occupied by grain crops cut for fodder in 1895. Soon after the fodder was removed the land was ploughed, and the seed was sown on August 1. Of the mammoth and common red clovers, 3 pounds of seed per plat were sown; of the alsike clover, $2\frac{1}{2}$ pounds; and of the crimson clover, 4 pounds. The seed of all varieties started promptly and well and all varieties went into the winter in excellent condition.

The crimson clover early in March appeared to be in good condition, but during the latter weeks of March it gradually weakened and died. By the first of April there was scarcely a plant in the field alive. This species appears unable to endure our average spring weather. The crimson clover plats were accordingly ploughed in April and resown, $5\frac{1}{2}$ pounds of seed per plat being used, on April 24. The seed started quickly, and, as will be seen by the tables which follow, this variety gave one good crop, at the rate of nearly 3 tons to the acre on the best plat. This clover was cut on July 17, at which time it was in *mid-bloom.* Notwithstanding frequent showers soon after, the stubble failed to start, and in a few weeks was almost entirely dead, at which time the plats were reploughed. It will undoubtedly be found necessary to cut this variety just as it begins to bloom, in order to insure later cuttings.

The very few plants in this field (as well as those from another with lighter soil) which survived the early spring weather were taken up and replanted, in order to secure seed, in the hope that we may in time by a continuance of this process of selection produce a strain or variety of this species which will prove hardy with us.

For culture as an annual it seems unlikely that crimson clover will prove of much importance, as in that case it would not give earlier fodder than the other clovers. Could it be cultivated as a winter annual, on the contrary, it must take an important place as a crop both for fodder and for green manuring, — for fodder chiefly, because it would be ready to cut at so early a date, and for green manuring, since it grows so rapidly.

Mammoth Clover. — This variety was cut on June 23, at which time it was not in full bloom. It was thought best to harvest, as it was lodging badly. On August 10 it was cut for the second time. It did not make sufficient growth thereafter to warrant cutting again. Though cut, therefore, but twice, while the common red clover was cut three times, the mammoth clover produced slightly more hay than the former. The two crops make a yield at the rate of rather more than $4\frac{1}{2}$ tons per acre. This hay is not objectionably coarse, or, rather, not much more so than that of the common red variety. This mammoth clover, as will be seen by reference to the table below showing composition of the crops, is not inferior in nutritive value to the common. The mammoth is to be especially recommended for sowing in mixtures of which timothy is a prominent part, as it matures more nearly with this grass than does the common red.

Common red clover calls for little special comment. Each of the three cuttings was made when the crop was a little past full bloom; the dates, June 19, July 28 and October 9. The average total yield of the plats (one-tenth of an acre each) is at the rate of a little more than $4\frac{1}{4}$ tons per acre. The composition of this variety will be found in the table which follows those showing yield and dry matter.

Alsike clover gave two excellent crops, cut respectively on June 19 and August 10: but, while the sod of both the mammoth and common red on November 3 appeared to be in excellent condition, the sod of this variety shows signs of weakness. Weeds are coming in to a considerable extent, principally sorrel. The table of composition shows this clover to be somewhat richer in nitrogenous nutrients (protein) than either of the others. This difference in its favor is in part offset by lower percentages of fat and extract, and it is doubtful whether the hay of this variety is worth more for food than that of either of the others. Alsike clover is especially recommended for soils which are rather too moist for the common red variety.

Field B. — *Trial of Clovers (Bone at Rate of 600 Pounds per Acre to All Plats).*

	Mammoth Clover.		Common Red Clover.		Alsike Clover.		Crimson Clover.	
	Plat 13. Muriate of Potash.	Plat 14. Sulphate of Potash.	Plat 15. Muriate of Potash.	Plat 16. Sulphate of Potash.	Plat 17. Muriate of Potash.	Plat 18. Sulphate of Potash.	Plat 19. Muriate of Potash.	Plat 20. Sulphate of Potash.
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
First crop,	615	650	455	455	620	455	575	595
Second crop,	295	305	276	294	325	200	-	-
Third crop,	-	-	120	120	-	-	-	-
Total crop,	910	955	851	869	945	655	575	595

Field B. — *Clovers (Dry Matter in the Crops).*

	Mammoth Clover.				Common Red Clover.				Alsike Clover.				Crimson Clover.			
	Plat 13.		Plat 14.		Plat 15.		Plat 16.		Plat 17.		Plat 18.		Plat 19.		Plat 20.	
	Per Cent.	Pounds.	Per Cent.	Pounds.	Per Cent.	Pounds.	Per Cent.	Pounds.	Per Cent	Pounds.	Per Cent.	Pounds.	Per Cent.	Pounds.	Per Cent.	Pounds.
First crop,	83.19	511.6	83.32	541.6	82.1	373.5	85.7	390.1	74.0	458.5	78.4	356.5	73.6	422.9	68.4	406.9
Second crop,	83.06	245.1	83.52	254.7	77.3	213.2	78.4	230.5	84.6	274.7	81.0	162.0	-	-	-	-
Third crop,	-	-	-	-	83.3	99.9	83.3	99.9	-	-	-	-	-	-	-	-
Total dry matter,	756.7		796.3		686.6		720.5		733.2		518.5		422.9		406.9	

Composition of Clover Hay.

POTASH SALT.	MAMMOTH.		COMMON RED.		ALSIKE.	
	Muriate (Per Cent.).	Sulphate (Per Cent.).	Muriate (Per Cent.).	Sulphate (Per Cent.).	Muriate (Per Cent.).	Sulphate (Per Cent.).
Water,	16.81	16.88	17.92	14.26	26.05	21.64
Dry matter,	83.19	83.32	82.08	85.74	73.95	78.36
	100.00	100.00	100.00	100.00	100.00	100.00
Dry matter contains: —						
Crude ash,	9.97	8.96	8.79	8.22	10.67	9.77
Crude cellulose,	30.35	30.40	31.46	30.24	30.32	30.23
Crude fat,	2.00	2.18	2.66	3.15	2.07	2.08
Crude protein,	14.65	14.86	13.34	12.61	16.48	15.82
Nitrogen-free extract matter,	43.03	43.60	43.75	45.78	40.46	42.10

Sulphate v. Muriate of Potash for Clovers. — This experiment with clovers was so carried out as to allow a careful comparison between the sulphate and the muriate as sources of potash for this crop, as well as the comparisons between varieties. A study of the figures giving yields shows that there seems to be no clearly defined difference in the effect of the two salts upon the total product. It is true that in the case of the alsike clover the muriate plat produced much the larger crop; but, since this was not the case with either of the other varieties, we are not justified in concluding that this difference is a direct consequence of the different manuring.

A study of the figures showing the composition of the crops from the several plats, however, reveals the fact that in every instance the percentage of nitrogen-free extract is greater in the hay raised on the sulphate of potash. It is true that the difference is not large, though in the case of the red clover it is sufficient to make a difference of rather over 140 pounds of this valuable class of nutrients in the product of one acre. It seems probable that this difference is due to the action of the chlorine of the muriate of potash in decreasing the formation of starch, — an effect which has often been noticed with the potato. Since, then, starch is

one of the most valuable constituents of foods, it follows that the sulphate is to be preferred to the muriate of potash, if it can be obtained at the same price. This, however, has not thus far been the case. At prevailing prices, the muriate would seem likely to be the more profitably employed.

4. Millets for Seed.

The three species of Japanese millet reported in previous years have been again cultivated for seed. The product has been at the following rates per acre: barn-yard millet (*Panicum crus-galli*), straw, 6,554 pounds, seed, 57 bushels; Japanese panicle millet (*Panicum miliaceum*), straw, 5,514 pounds, seed, 26 bushels; common Japanese millet (*Panicum italicum*), straw, 5,017 pounds, seed, 53.3 bushels. The weights per bushel of the seed are respectively 35, 54 and 42 pounds. Owing to unfavorable weather, a large amount of the seed of the barn-yard millet wasted in the field, hence the yield appears smaller than it actually was.

5. Millets for Fodder.

(*a*) *First Experiment.*— Our three species of Japanese millets, viz., the "barn-yard," the "panicle" and the "common," have been carefully compared with each other and with Hungarian grass as fodder crops upon a somewhat extensive scale. Nearly one-half an acre of the barn-yard variety and one-third of an acre each of the others were sown. The soil was a rather heavy loam, which for several years has been manured only with fertilizers. On a part of each plat the fertilizers applied were bone meal, lime and double sulphate of potash and magnesia; on the balance of each, nitrate of soda, Thomas phosphatic slag and the double sulphate were applied. To Dr. Goessmann is left the discussion of the results of the two systems of manuring, as they were planned by him. We have here to do only with the comparison of the varieties under trial. Suffice it to say that the fertilizers were applied in only moderate amounts, and that they were spread after ploughing, and harrowed in. All varieties were sown on June 2, the seed covered with Breed's weeder and the land then rolled.

The following table shows the amount of seed sown, the date of cutting and the yield of well-cured hay. For convenience of comparison, the yield of the "barn-yard" variety is given for the same area as the others: —

Varieties of Millet (One-third Acre Each).

VARIETY.	Quantity of Seed sown (Quarts).	Date of Cutting.	Yield of Hay (Pounds).
Hungarian grass,	6½	Aug. 15,	1,730
Japanese common millet,	8	Aug. 26,	2,025
Japanese panicle millet,	8	Aug. 15,	2,410
Japanese barn-yard millet,	4⅓	Aug. 15,	2,603

The fact must be stated that the quantity of seed of the "barn-yard" variety proved to have been rather too great for a season so favorable for rank growth as was the last. The crop of this variety lodged badly, and was therefore cut rather before it would otherwise have been. It was the intention to cut each variety when the seed of the plants on the earliest portion of the plat was well formed, but before it began to harden; and this was done except in the case of the barn-yard variety, which, as before stated, was cut a little before this stage was reached. The several varieties yielded, as determined by calculation from the results given in the above table, at the following rates per acre of well-cured hay: Japanese barn-yard millet, 7,830 pounds; Japanese panicle millet, 7,230 pounds; Japanese common millet, 6,075 pounds; and Hungarian grass, 5,190 pounds.

(*b*) *Second Experiment.* — Seventeen varieties of millet, including the 4 above discussed, were given a trial upon a smaller scale, upon similar soil and under similar conditions to those just described. The plats in this experiment were ten rods long and one rod wide, containing, therefore, one-sixteenth of an acre each. The results are shown in the table which follows: —

Millets, Variety Tests (Plats One-sixteenth Acre Each).

	Quantity of Seed (Quarts).	Height of Plants (Inches).	Date of Cutting.	Yield of Hay (Pounds).
Canary bird seed,* . .	2	30	Aug. 25,	295
Early Harvest,. . .	2	36	Aug. 4,	325
Mukodamaski (Japanese),	2	42	Sept. 8,	540
Golden, . .	2	54	Sept. 8,	610
Golden Wonder, . .	2	48	Aug. 13,	480
Hokkaido (Japanese), .	2	47	Aug. 25,	430
Japanese common, . .	2	48	Aug. 25,	475
Hungarian, .	2	39	Aug. 13,	550
Japanese white panicle, .	1½	78	Aug. 31,	840
Chinese. . . .	1½	51	Aug. 4,	460
Common broom corn, .	1½	40	July 28,	450
White French, . . .	1½	48	July 31,	310
Red French, . . .	1½	34	July 28,	300
Hog,.	1½	37	July 28,	370
California, . . .	1½	37	July 28,	370
Japanese panicle, . .	1½	55	Aug. 15,	490
Japanese barn-yard, .	1	66	Aug. 13,	620

* In this table the names under which the varieties were advertised are used in the case of all purchased sorts. The Japanese varieties are of our own importation or production.

The varieties especially noteworthy for large production are the Japanese white panicle and the Japanese barn-yard, the latter not doing its best either in this trial or the other, on account of having been sown too thick. In estimating the significance of these results, this fact must be kept in mind. It is further important to state that the barn-yard variety is far less harsh and woody than any of the other large-growing varieties of millet. Its extreme succulence, however, makes it rather difficult to cure. We have had most success in handling it as clover is usually handled by the best farmers, viz., by curing mostly in the cock. It is our intention to publish analyses of these millets in a later report or bulletin.

Miscellaneous Crops.

A considerable number of miscellaneous crops have been under trial upon a small scale, or have been cultivated for illustrative purposes. Under this class may be included 37 species of grasses; 22 varieties of millet for seed; 26 species and varieties of leguminous fodder or green manur-

ing crops; 7 varieties of oats; several varieties of sorghum recommended for fodder, — saccaline, iris, beggar weed and cystisus, all sent in for trial as fodder crops; Ankee grass and 2 varieties of sugar beets. Many of these require no especial notice, while most of the others can be sufficiently discussed in a few words.

The grasses include a considerable number of species, received through the kindness of Professor Fletcher of the Ontario Agricultural College, which are as yet entirely unknown to the general cultivator. Several among them are indigenous to America, and appear to possess qualities which fit them in an especial degree for our soil, climate and conditions, and must make them of great value in our agriculture. The seeds of all these grasses were sown last spring, and it therefore follows that they have not yet had a trial sufficiently long to warrant definite conclusions. Among those species, however, which, so far as can be judged from one season's growth, appear to be expressly promising, are the following: *Bromus schradeii*, *Bromus ciliatus*, *Agropyrum tenerum* and *Avena flavescens vera*. Seven indigenous species from seed collected in Amherst and vicinity are under trial, and two species were sent for trial by the United States Department of Agriculture. One of these, *Eragrostis New Mexicana*, appears promising; the other, *Elensine Egyptiaca*, gave one good cutting, but failed to start thereafter. If an annual, as this behavior indicates, it can hardly prove important.

The Millets. — Among the 22 varieties included in this trial are most of those cultivated as fodder crops, besides a few others which were of especial interest. In this trial all varieties were allowed to ripen seed. As it was, however, found impossible to prevent the birds from taking some of the seed, — a serious matter, where the quantities are small, — it is not deemed important to publish the figures showing yields.

It has been decided, after the experience of two years in cultivating these varieties both for fodder and for seed, *that there is no appreciable difference between the varieties sold by various seedsmen under the following names: White French, Chinese, broom corn and California.* This variety, as well

as the French, red French and hog millets, are all apparently of the same species as the Japanese panicle millet, viz., *Panicum miliaceum*, and are all much inferior to the Japanese in productive capacity, and inferior, I believe, also, to Hungarian grass.

Leguminous Fodder and Green Manuring Crops.

Most of the species and varieties, 26 in number, coming under this class, have been named, described and commented upon in previous reports, and require no further mention at this time. Of a few it is necessary to speak briefly.

1. *Flat Pea* (*Lathyrus sylvestris*). — Of all the crops which have been urged upon the attention of the American farming public in recent years, few have been so highly praised as this. I am compelled to conclude, after three years' trial, and in view also of the experience of others, that it is not a crop which can prove valuable among us. The principal points against it are the following: —

(*a*) The seed germinates with extreme slowness and uncertainty, making this a difficult and expensive crop to start. It would hardly be possible to stock a field with it, except by starting the plants in a bed and then transplanting to the field.

(*b*) The plants are not perfectly hardy under average conditions.

(*c*) The plants in growing sprawl over the ground in such a manner as to make this a difficult crop to cut.

(*d*) The forage is not relished by cattle. This statement is based largely upon distinguished German authority.*

In conclusion, I may state that this crop does not appear to have made any important place for itself in the land of its origin, Germany.

2. "*Sweet Clover*" (*Melilotus alba*). — Two plats in Field B, each of one-tenth of an acre, were sown with this clover, as it was thought possible that it might prove useful for the silo or for green manuring. These plats are designated by numbers 10 and 11. Both received ground and steamed bone meal at the rate of 600 pounds per acre;

* Dr. Max Maercker and Dr. Julius Kuehn.

Plat 10, muriate of potash; and Plat 11, high-grade sulphate of potash, in both cases at the rate of 200 pounds per acre. The seed was sown at the rate of 3 pounds per plat. The plants were badly thrown out of the ground during the winter, but most of them survived. The growth, however, was poor, and both were cut June 19, yielding: Plat 11, 200 pounds; Plat 12, 285 pounds, green weight.

It was noticed that isolated plants or clumps of plants while growing had a much deeper shade of green, and were in many instances three times the average height of the other plants in the field. Examination revealed the fact that in every instance the roots of these plants were thickly set with the nodules characteristic of the Leguminosæ, while such nodules were either entirely or almost entirely absent from the roots of the feebler plants, which class included a large majority of those in the plats. It is believed that this difference accounts for the wide variation in the different plants. These nodules are due to the development upon the roots of specific bacteria (microscopic fungi). These bacteria must develop, like other plants, from seed; and this seed, when the culture of a new crop of this class is first begun in a given locality, is not present as a rule in such quantity as to insure a full development of the nodules. Such as do develop must come from spores which adhere to the seed of the new crop. In the case of a second or later crop the spores are more abundant, for, as is often the case with weed seeds, the few developed the first year, remaining in the soil with the roots of the crop, retain their vitality, and accordingly the crop does better when grown a second or third time than at first, because the more abundant spores cause a more abundant development of root nodules upon which the assimilation of free atmospheric nitrogen depends.

In this case sweet clover had never been grown upon these plats before; hence, as there were probably no spores in the soil, and nodules could come only from the few spores which happened to adhere to the seed sown, there were in the aggregate but few and the crop did poorly. The plats have been sown again with the same crop, in the expectation that in the second year of its culture it will do

better. The probability that this will be the case should never be lost sight of when new leguminous crops are under trial.

3. *The Horse Bean* (*Vicia faba*). — This crop, so highly prized by Professor Robertson of Ontario, has been given a rather more extensive trial than most of the crops in this class during each of the last two years. It does not commend itself to my judgment as a fodder crop, for which it is recommended. It is subject to a blight, which often seriously injures it; it sets comparatively little seed, most of the blossoms blighting; and in yield it does not equal other leguminous crops which are more easily cultivated.

4. *Field Peas.* — During the past season we have tried three new varieties of field peas from Canada, all of which appear to be excellent sorts for field culture with oats or barley as fodder crops. There does not appear to be a very wide difference between the three in productive capacity. All were remarkably free from mildew. The table below gives all information necessary for a comparative estimate of these varieties: —

Field Peas (2 Rows, Each 70 Feet Long).

	English Gray.	Canada Beauty.	Prussian Blue.
	Pounds.	Pounds.	Pounds.
Total yield, pods filled but vines still green,	165	200	205
	Per Cent.	Per Cent.	Per Cent.
Dry matter,	14.77	18.28	18.06
Water,	85.23	81.72	81.94
	100.00	100.00	100.00
Dry matter contains: —			
Crude ash,	9.56	7.80	–
Crude cellulose,	30.23	28.99	–
Crude fat,	3.16	2.74	–
Crude protein,	20.65	16.14	–
Nitrogen-free extract,	36.40	44.33	–
	100.00	100.00	–

It is noticeable that the first variety is considerably richer in protein than the others; but, as the yield is so much smaller, either of the latter would seem to be preferable as fodder crops. They not only yield more heavily, but the fodder contains a considerably larger percentage of dry matter, which gives them greater food value. It might be thought that the Canada Beauty and Prussian Blue must have been more mature than the others, but this is not believed to have been the case. The effort was to harvest each in the same stage of maturity. Moreover, all were planted on the same date, May 2, and they were harvested as follows: English Gray, July 11; Canada Beauty, July 14; and Prussian Blue, July 2.

Oats. — Five varieties of *common oats* were tried upon a small scale, chiefly with a view to determining whether a variety could be found capable, under our peculiar climatic and soil conditions, of resisting rust. The attempt was a failure so far as this particular object is concerned, as all varieties rusted, and apparently to practically the same extent. The crop, however, was a fairly good one. The area occupied by each variety was 7 by 85 feet (one seventy-third of an acre). The yield is shown below: —

Varieties of Oats (One Seventy-third Acre Each).

	Straw (Pounds).	Grain (Pounds).	Weight per Bushel (Pounds).
Siberian,	57	30	32
Lincoln,	52	34	31
Black Beauty,	66	35	29½
New Illinois,	59	32	30½
White Poland,	52	27	33

A yield of 31 pounds is almost exactly at the rate of 70 bushels of 32 pounds each per acre.

Winter Oats. — Two varieties of winter oats have been tried during the past year. The seed of one sort was obtained from Dover, Del., of the other from Charlottesville, Va. In both of these States winter oats are considerably cultivated, and, as the impression there seemed to be that

these oats are quite hardy, it was decided to try them. We were also invited by Peter Henderson & Co. to make such a trial. One plat of one-tenth of an acre in rather heavy but well-drained loam and another of about three-eighths of an acre in medium loam were selected for the experiment. The seed was sown in drills about the last of September, and the oats had made a good start before cold weather. *Not a single plant survived the winter in either plat.*

Sorghum Varieties. — Several varieties of reputed fodder plants belonging to the genus *Sorghum* have been under trial in a small way during each of the last few years, usually at the suggestion of the United States Department of Agriculture. It is believed by some of the officers of this department that plants of this class, having greater capacity to resist drought than many others, will prove valuable fodder plants; and this opinion is seemingly justified by the results of trials in some of the western States. In Kansas, indeed, very favorable results have been obtained with some of them as grain crops. Such of these crops as have been tried here have always been put in warm, well-drained soil, but they have in no instance equalled Indian corn as fodder crops. Those tried this year are the following: "Jerusalem corn," "Red Kaffir corn," "White Kaffir corn" and "Millo maize." "Teosinte," although not a sorghum, can be considered with them. All of these grow very slowly at first, which increases the cost of culture largely, as compared with corn. None of them have ripened seed with us. *For the various reasons above stated, I do not regard any of these crops as likely to prove valuable for Massachusetts farmers.*

Saccaline. — Seed obtained in 1895 was started in a bed in the open air, and in midsummer plants were set in two plats, one in light sandy soil, the other in a heavy moist soil. The plants in the latter grew vigorously until late fall, those in the sandy soil but feebly. During the winter about 75 per cent. of the plants in both plats were killed. A similar proportion of plants temporarily set in a bed in medium loam died during the winter. Such plants as survived the winter in the moist soil made a very early start in the spring, but were entirely destroyed by later frosts. I judge that the plant is far from being sufficiently

hardy for our climate. Moreover, it is not much relished by stock unless cut very young. Further, it should be remembered, by any one trying it in a locality where it thrives, that it spreads rapidly by means of underground stems, and that it is extremely difficult to eradicate when once it has gained possession of the ground.

Iris pabularia. — Seeds were sent for trial by J. M. Thorburn & Co. of New York in 1895, the statement being made that it might prove valuable as a fodder crop. Germination was slow, the plants grew but feebly and during last winter all were killed.

Cystisus proliferus albus. — Seeds were received for trial of this plant as a fodder crop in the spring of 1895. Germination was imperfect, the plants did not make much growth and all died during last winter.

Florida Beggar Weed (*Desmodium tortuosum*). — Seeds sent for trial as a possibly valuable fodder crop were sown May 4. The plants grew to be about 3 feet tall, with numerous branches and leaves, which are eaten by stock. The main stem is hard and woody. The amount of fodder produced does not equal that produced by the soya bean in the same time. The plants did not reach the blossoming stage and were killed to the ground by the first frost. I judge that it will have no value here as a fodder plant.

Spurry (*Spergula arvensis*). — Two varieties, "small" and "giant," were under trial on a small scale. Neither produced fodder enough to make it of value.

Ankee Grass (*Panicum crus-galli*). — Seed of a variety of this species (the same as that to which our Japanese barnyard millet belongs) was received from the United States Department of Agriculture, with the request that we submit it to trial. It was stated that it had been collected by C. R. Orcutt, and that the seed was used as food by the Indians of South California and Arizona. The seed was sown May 4, and the crop was given careful culture. The plants grew about 5 feet tall, the stems were coarse, harsh and woody, brown in color, quite leafy. Panicles open like those of the common weed (barn-yard grass), but without awns, large. Seeds did not ripen. As compared with the Japanese barnyard millet, this variety is not as tall, coarser and more

woody and much later. It is decidedly inferior to the Japanese variety in every respect as a fodder crop for this locality. It is quite probable, however, considering its origin, that the Ankee grass will endure drought better than the Japanese barn-yard millet.

Millets under False Names. — The reputation of some of our Japanese millets is such that seed has for the last two years been offered in some quarters which is not genuine. We have received and tested three such samples, from widely different sources. In one of these cases the mistake may have been inadvertent. The variety was sold as Japanese barn-yard millet; it proved to be the Japanese panicle millet, — a widely different sort. *It should be remembered that we have sent out three Japanese millets, viz., the barn-yard, panicle and common. The first we consider to be the most valuable as a fodder crop.*

Sulphate of Iron as a Fertilizer.

A recent English work on manures and fertilizers* lays great stress upon the value of *sulphate of iron* as a fertilizer, and contains figures giving the results of many apparently careful experiments, all tending to show that this chemical often has a considerable influence in increasing crops. The opinions of Mr. Griffiths upon this point, so far as I am aware, are not shared by most authorities, and I had not much confidence that experiments here would give results similar to those he reports. Still, it is our place to put such questions to the test. Accordingly a piece of land that for some years has been manured yearly at the rate of 600 pounds ground bone and 200 pounds muriate of potash per acre, and which has produced a variety of crops, including grass, potatoes and clover, was selected for the purpose. It was divided into four plats, and all received the customary application of bone and potash, applied in September, 1895. These plats contain one-thirtieth of an acre each. The crop was the medium green soya bean, planted June 13. Sulphate of iron was applied to two of these plats, Nos. 1 and 4, on June 24, just as the beans were coming up, at the rate of 80 pounds per acre.

* Griffiths, "Farm Manures."

It has been claimed by Griffiths that the use of this salt favors chlorophyll formation, and that it therefore causes a perceptibly deeper shade of green in the leaves in the plants to which it is applied. No difference could be detected during the season. The average crop (cut green for the silo) where the sulphate of iron was applied was 462½ pounds, the average of the other plats 445 pounds, — a difference of 17½ pounds in favor of the treatment, or at the rate of 525 pounds per acre. I consider this difference too small to be of much significance.

"Bug Death."

This is a preparation sent to us by the Danforth Chemical Company, Leominster, Mass., as a substitute for Paris green as a poison for potato bugs and as a preventive of blight. It was received late in the season, the "bugs" being full grown when we were able to use it the first time. It kills them, but not as quickly as Paris green; and as, in showery weather particularly, rapidity of action is desirable, I do not look upon it as equal in value to that poison for this and similar purposes. The "Bug Death" had no apparent effect in preventing blight.

Atomizer for applying the Bug Death.

The Danforth Chemical Company sent with the "Bug Death" a large atomizer, which they recommended for its application. This material and similar dry poisons can be applied with this atomizer, but it is entirely unsuited to use upon a large scale. The hand soon becomes excessively and painfully weary from the motion required, while the time occupied is far greater than by other means which are within the reach of all. It required twenty-eight minutes to cover a row with the atomizer, while the same length of row was covered by the use of Leggett's gun in eight minutes.

Fungiroid.

"Fungiroid," sold by the manufacturers of Leggett's dry insect powder gun as a means of preventing potato blight, has been given a thorough trial. Both the "*Fungiroid" in combination with Paris green*, furnished and recommended by the company, and in the latter part of the season, when

the bugs had ceased to be troublesome, the *pure* "*Fungiroid*," were employed. The season was hot, with frequent showers, furnishing, therefore, conditions highly favorable to the development of parasitic fungi, and extremely unfavorable to the action of the "Fungiroid." It was, however, reapplied at frequent intervals, and always after a heavy rain and while the vines were moist.

The treatment was applied to one row each of the 60 varieties in our variety test. One row each of 38 of these varieties, in an adjoining plat, upon similar soil and grown under precisely similar conditions, was left untreated. No difference whatever could be detected in the extent to which blight affected the treated and untreated vines. "*Fungiroid*" *and Paris green mixture* (prepared) was applied at the rate of 2 pounds per acre to the vines of the treated plat with Leggett's gun, and in accordance with directions, on each of the following dates: July 13, 18, 22 and 24. Pure "Fungiroid" was applied twice, at the rate of 1½ pounds per acre, and in the same manner, on August 1 and 3. By the latter date blight had affected all varieties in the plat and to a considerable extent in most cases. The yield from 38 rows treated as described was 7,887½ pounds of large and 983 pounds of small potatoes. The 38 rows which were untreated produced 8,407 pounds of large and 960 pounds of small tubers. The results surely indicate no favorable influence due to the use of "Fungiroid."

Scab of Potatoes.

It has been thought by some experimenters that, by an application of sulphur at the time of planting, "scab" of potatoes, even in infected soil, could be prevented. Accordingly, as we had such an infected soil where a very scabby crop was raised last season, it was decided to test this point. The plan of the experiment was as follows: one-half the seed required was treated with corrosive sublimate solution in the usual way; then 240 hills were planted with each kind of seed (treated and untreated), and in the furrow with one-half of these hills sulphur at the rate of 300 pounds per acre was scattered at time of planting. The table below shows the results: —

Sulphur for Prevention of Scab of Potatoes (120 Hills Each).

TREATMENT.		Large Tubers.			Small Tubers.
		Free of Scab (Pounds).	Slightly Scabby (Pounds).	Badly Scabby (Pounds).	
Seed treated with corrosive sublimate,	no sulphur,	21	78½	48	24
	sulphur,	2	80½	56	15
Seed untreated,	no sulphur,	2 tubers	70½	84½	19½
	sulphur,	3 tubers	67	96	20

The use of sulphur in the drill appears to have been absolutely without effect. The table indicates that even when seed is planted in infected land the treatment with corrosive sublimate is somewhat beneficial.

Trial of Hay Caps.

Another season's use, and very frequent and extended use, of the three styles of hay caps mentioned in my last report, viz., the Symmes' paper board, oiled cotton and cotton impregnated with tannin, has led to the following conclusions: —

1. Caps of some sort are extremely useful, especially with such crops as clover, millets, oats and peas, and other slow-curing crops, especially those much injured by excessive handling.

2. The Symmes' cap is most quickly applied, — an important point, — and is best liked. It appears to be wearing very well.

3. Of the two styles of cloth caps in use, those impregnated with tannin are most durable. The oiled caps are more mildewed than the others and have become much more torn.

4. It has been found that in some cases, where clover has been cocked quite green and covered with the three kinds of caps and allowed to stand for some time with frequent rains, it has kept better under the cloth than under the Symmes' caps. The porosity of the former in such cases appears to be an advantage.

Poultry Experiments.

Poultry experiments were continued during the winter of 1895–96 upon a small scale. Our attention has been confined to two points, viz.: —

1. Effect upon egg-production of the use of condition powders.

2. Comparative value for egg-production of dry ground animal meal and cut fresh bone.

1. Effect of Condition Powder upon Egg-production.

The experiment to test the value of condition powder in feeding for eggs was begun February 9 and continued until April 28. We used two lots of fowls, selected with the utmost care with respect to similar characteristics in the two lots. Each lot contained 3 barred Plymouth Rock hens, 8 light Brahma hens, 6 light Brahma pullets and 2 Wyandotte-light Brahma pullets. The hens were one and three-quarters years old at the time the experiment began. Each lot, consisting of 19 fowls, occupied a detached house having two compartments (scratching shed and closed roosting and nest room), respectively 8 by 12 and 10 by 12 feet in size, the nest room with two windows. These houses adjoin each other and both have precisely the same exposure. The two lots were fed as follows: in the morning they received a mash which was mixed hot the previous evening; at noon, and again one hour before sundown, whole grain was scattered in the straw in the scratching sheds. Artificial grit, oyster shells and pure water were kept always before them. The only difference in the management of the two lots was that condition powder was mixed in the mash for one lot, in accordance with directions furnished with the powder. This experiment seemed important, in view of the large amount of money, in the aggregate, which is expended in the purchase of such powders; and, notwithstanding the very general impression that they are useful, in the absence of any definite proof of the fact. *I would call especial attention to the fact, — which, though generally well known, is often lost sight of, — that no one experiment can settle this question in the one way or the other.* The results of this experiment are pub-

lished, then, not as settling the question, but simply as evidence bearing upon an important point, to be accepted only for what it may be worth.

The foods used in this experiment and in the other described later, and their composition, are shown below: —

Composition of Air-dry Foods used in Poultry Experiments (Parts in 100).

	Water.	Crude Ash.	Crude Cellulose.	Crude Fat.	Crude Protein.	Nitrogen-free Extract.
Ground clover,	9.53	7.43	27.80	1.93	13.65	39.66
Wheat bran,	9.56	5.27	8.85	5.37	17.69	53.26
Animal meal,	5.08	28.63	-	16.18	40.03	10.08
Cut bone,	29.67	24.06	-	26.13	20.19	-
New-process linseed meal,	9.35	4.48	6.58	6.39	38.06	35.14
Buffalo gluten meal,	7.14	.84	7.07	12.67	23.31	48.97
Chicago gluten meal,	8.10	.83	3.34	5.57	36.51	45.65
Wheat middlings,	10.93	4.03	6.95	5.30	17.28	55.51
Whole wheat,	10.60	1.69	2.17	1.93	13.19	70.42
Whole oats,	10.06	2.77	8.71	4.87	14.53	59.06
Soya-bean meal,	9.24	5.02	3.87	16.25	34.75	30.87

The kinds and total amounts of the several foods used in this experiment for the lot of fowls having condition powders are as follows (in pounds): whole wheat, 100; whole oats, 99.5; wheat bran, 19.8; wheat middlings, 19.8; ground clover, 19.8; new-process linseed meal, 9.9; animal meal, 9.9; soya-bean meal, 9.9; cut bones, 3. Two pounds of condition powder were used. All the meals, bran, middlings, ground clover and bones were given in the form of the morning mash. The total number of pounds of food used was 291.6. The nutritive ratio, based upon composition (as digestibility by fowls is not known), is 1 : 4.5. The cost of all the food used was $3.43, not including the condition powder.

The lot of fowls which received no condition powder received foods as follows (in pounds): whole wheat, 99.5; whole oats, 100; wheat bran, 19.3; wheat middlings, 19.3; ground clover, 19.3; new-process linseed meal, 9.7; animal

meal, 9.7; soya-bean meal, 9.7; and cut bone, 3. Total number of pounds, 289.5; total cost, $3.39; nutritive ratio, 1 : 4.5.

The results and leading details of the experiment are shown in the table below: —

Condition Powders for Egg-production.

Experiment, February 9 to April 28.	Duration of Experiment.	Total Food consumed.	Cost of Food per Day per Fowl.	Number Eggs produced.	Dry Matter in Food per Egg.	Cost of Food per Egg.
	Days.	Pounds.	Cents.		Pounds.	Cents.
19 fowls, condition powder, . . .	79	291.6	.23	163	1.611	2.1
19 fowls, no condition powder, . .		289.5	.23	195	1.333	1.8

In the above estimate the cost of the condition powder is not included. This amounts to $1, which would make the cost per egg 2.7 cents in the case of the fowls receiving it.

The fowls receiving no condition powder laid their first egg on February 12; those receiving it, their first egg on March 16, at which time the other lot had laid 24 eggs. One hen in each lot died during the experiment. At its close the fowls in both lots appeared to be in about equal condition of health, but two in the condition-powder lot had begun to moult, while there were no indications of moulting in the other lot. There was no material difference in the size or appearance of the eggs from the two lots. This experiment is now being repeated, with lots of pullets most carefully selected with reference to it, having been begun on Jan. 1, 1897.

2. Animal Meal v. Cut Bone for Egg-production.

The general conditions of this experiment were similar to those in the experiment to test the value of condition powder. Each house contained 2 barred Plymouth Rock and 10 light Brahma hens, 5 light Brahma pullets and 2 white Wyandotte-light Brahma pullets; total, 19 fowls. The experiment began February 9 and ended April 28.

The food received by the lot having cut bone was as follows (in pounds); whole wheat, 99.5; oats, 100; wheat

bran, 18.5; wheat middlings, 18.5; Chicago gluten meal, 18.5; ground clover, 18.5; cut bone, 10; total, 283.5 pounds; cost, $3.25; nutritive ratio, 1 : 4.8.

The other lot received essentially the same foods, except that in place of the bone it got 9.7 pounds of animal meal; total food, 287 pounds; cost, $3.26; nutritive ratio, 1 : 4.9.

The leading details and results are shown in the following table: —

Cut Bone v. Animal Meal for Egg-production.

Began February 9, ended April 28.	Duration of Experiment.	Total Food consumed.	Cost of Food per Fowl daily.	Number of Eggs produced.	Dry Matter in Food per Egg.	Cost of Food per Egg.
	Days.	Pounds.	Cents.		Pounds.	Cents.
Cut bone lot,	79	283.5	.22	269	.940	1.2
Animal meal lot,		287.0	.22	145*	1.796	2.2

* One soft shelled.

In the above estimate of cost the labor required to cut the bones is included. The results indicate a decided advantage in favor of the bone. During last year two experiments were tried, one of which resulted favorably to the bone, the other to the animal meal. Last year there was some diarrhœa among the fowls having bone, this being given alone. This year the bone was fed in the mash, and there has been no such trouble. There has been this year no perceptible difference either in the condition of the fowls in the two lots or in the size or character of the eggs produced. The experiment indicates, then, a decided advantage in favor of the cut bone. This experiment is now being repeated.

REPORT OF THE METEOROLOGIST.

LEONARD METCALF.

During the past year the usual meteorological observations have been continued, and the results have been compiled with those of previous years. A special bulletin will be published with the annual summary of observations for the year 1896, in January, 1897, giving the mean annual and the maximum and minimum records for this station for the past eight years, *i.e.*, since the equipment of our observatory.

The advisability of making a change in the time and frequency of taking the observations, from tri-daily readings at 7 A.M., 2 P.M. and 9 P.M., to bi-daily readings at 8 A.M. and 8 P.M., to conform with the present method of the U. S. Weather Bureau, was considered; but, after discussing the subject thoroughly with the department at Boston and at Washington, it was deemed unwise to make the change, and the observations have therefore been taken three times a day, as heretofore.

After a careful study of the thermometer records of the tower shelter, it was found that the local conditions of exposure were such as to seriously affect the accuracy of the temperature readings, and the Draper thermograph, by which the mean daily air temperature at the tower was found, was removed to the ground shelter, where its readings are checked and corrected three times a day by a standard mercury thermometer and by the maximum and minimum thermometers previously kept there. While record is still kept of the maximum and minimum air temperatures in the tower shelter, it is no longer published. The wet and dry bulb thermometers were also removed to the ground shelter, and the wet-bulb reading or "sensible temperature" of the air is now published, as well as the dry-bulb reading. This "sensible

temperature" is of course the temperature of the atmosphere as we ordinarily feel it, as the sensible temperature is directly dependent upon the relative humidity of the air, and hence upon the cooling effect of the evaporation of the surface moisture.

After a careful comparison of the rainfall records of the ground and the tower, obtained in each case by United States Weather Bureau rain gauge, it was found that the tower records were so affected by upward wind currents, due to the shape of the roof, as to render them of very doubtful value. The tower "precipitation" observations have therefore been discontinued.

Some additional records have been kept during the past year and will be continued this year. Among these are the number of days of sleighing and the amount of snow on the ground at the beginning of each week, the latter being reported to the New England Weather Bureau weekly. Record has also been kept of the accuracy of the forecasts received daily at this station; this record shows that, while the monthly percentage of correct forecasts has varied from 69 per cent. to 90 per cent. during the year, the mean percentage of accuracy of forecasts has been 78 per cent.

A few new instruments have been added to the station's equipment: two sets of Green maximum and minimum thermometers; six mercury thermometers, United States Signal Service pattern, made by Green; and a thermophone,* with four resistance temperature coils, made by E. S. Ritchie & Sons, the latter instruments being intended for experiments on soil temperatures.

Through the courtesy of Professor Whitney, one of his assistants, Mr. Thomas H. Means of the Division of Soils, Department of Agriculture, was sent to Amherst in the middle of July to install a set of Professor Whitney's apparatus for the determination of soil temperature and moisture. Soil-temperature electrodes and moisture-resistance plates were buried in grass land, a short distance from the ground shelter, at five different depths, from the surface of the ground to a depth of two feet; and from that time, the middle of

* The thermophone was recently designed and patented by Messrs. Henry E. Warren and George C. Whipple.

July, until the latter part of August, when the reading instrument broke down, daily records of the soil temperature and moisture were taken. The reading instrument above referred to was designed by Professor Whitney, and is a form of Wheatstone's bridge, reading the electrical resistance of the temperature cell and of the soil itself, from which data the temperature and moisture of the soil are computed.

Early in September the thermophone was received from Messrs. Ritchie & Sons, and its temperature-resistance coils were buried not far from the Whitney apparatus, at depths of three, twelve, twenty-four and thirty-six inches respectively. On this have been taken tri-daily soil temperature observations to the present time, and these records will be continued throughout the winter, the results being plotted each month, at its close, for purposes of comparison.

In the spring the thermometer coils will probably be taken up and put down in another place for observations, together with other instruments, on soil and air temperatures on an experimental corn plot; as plans have been formulated in co-operation with Doctors Allen, True and Whitney of the Department of Agriculture at Washington, and considerable work has been done preliminary to undertaking at Amherst a series of experiments bearing upon soil temperatures and moistures in their relation to the growth and advancement of crops.

REPORT OF THE HORTICULTURIST.

SAMUEL T. MAYNARD.

The number of varieties of fruits tested during the past season has been greatly increased, and the testing of a large number of varieties of vegetable seeds has been added to the work.

A large addition of varieties of apples, Japanese plums, peaches, cherries and the new species of raspberries and blackberries has been made by purchase of young stock, or by budding or grafting into stocks already established.

Spraying.

The protection of fruit and garden crops from insects and fungous pests has formed an important part of the work of this division, the results of which again emphasize the fact that good fruit cannot be grown without more or less use of insecticides and fungicides. The most approved apparatus and the new methods of application, as well as the new insecticides and fungicides, are given a very careful trial as soon after their introduction as possible.

The insecticides most used are Paris green, kerosene emulsion, hellebore and pyrethum or insect powder. In the greenhouses lemon oil has proved the most valuable substance for keeping down scale and mealy bugs.

The fungicides most used are copper sulphate solutions, Bordeaux mixture and ammoniacal carbonate of copper.

Dry Bordeaux Mixture.

During the winter and spring many inquiries as to the value of the dry Bordeaux mixture and methods of manufacture were received, and several parties began its manufacture and put it on the market. Many samples were sent us for

trial, and the results of the tests were carefully noted. As far as can be determined from one season's trial, the results have *not* been satisfactory, for the following reasons: first, that the material is not in sufficiently fine condition; second, that it is impossible to make it adhere for any considerable time to the foliage or other parts of the plants even when applied to a wet surface; third, that there is a great waste of material, much of it falling to the ground. After careful investigation, we have not noticed any marked beneficial result following its use. For the above reasons, the dry Bordeaux mixture does not appear to be as efficient as that in a liquid form.

Steam Spraying Outfit.

One of the greatest obstacles to the use of insect and fungi destroyers has been the difficulty of obtaining pumps of sufficient power to enable the application of liquids to be made thoroughly, as fast as an ordinary team would move along among trees or garden crops; and a careful trial of a steam spraying outfit has been one of the features of the past season's work. As the result of repeated trial, we feel warranted in the assertion that, when run with care and skill, very satisfactory work can be done better and more cheaply than when done by hand or by the gear machines. It is of course understood that the manipulator must be thoroughly acquainted with the construction of the engine and pump, and be skilful in keeping all parts in perfect working order. The cost of such spraying outfits, of which several are now offered in the market, and ranging in price from $200 to $400, is much against its use by the small farmer or fruit grower; but in almost every village or town the work of spraying for a large number of individuals by the single owner of an outfit could be done at a less cost than if each person were to equip himself with small and imperfectly working pumps. This would probably be found more satisfactory than if the outfit were owned by a number of individuals. A steam engine suitable for this work, and fitted with a fly wheel, so that the power could be utilized, when not needed for spraying, for cutting wood, corn fodder or ensilage, grinding grain, pumping water for stock or irrigation, would be a source of profit in many directions.

Seed Testing.

Complaints having been frequently received affecting the germinating qualities of seeds and vegetables and their purity, coupled with requests for examination and testing of the same, an extended investigation was undertaken of seeds of standard varieties from prominent dealers in different sections of the country. In all, 367 different packages of seeds were tested, each variety involving four distinct tests. These were obtained from seven of the leading seed dealers, as follows: 4 from Massachusetts, 1 from New York City, 1 from Philadelphia, Pa., and 1 from Detroit, Mich. The number of varieties tested was: beets, 4 (28 packages);* cabbage, 5 (35 packages); cauliflower, 3 (21 packages); celery, 5 (30 packages); cucumbers, 4 (28 packages); lettuce, 7 (27 packages); melons, 5 (23 packages); onions, 5 (30 packages); parsnips, 9 (18 packages); peas, 4 (28 packages); radishes, 6 (24 packages); spinach, 8 (19 packages); squashes, 4 (28 packages); tomatoes, 4 (28 packages).

These seeds were first tested for their germinating qualities by two different methods under glass. These were also noted when planted in the field, and careful observations made and recorded from time to time as to vigor of growth. At the end of the season the characteristics of foliage and products were carefully determined, and the crop of each strain weighed. Each kind of vegetable was planted in soil best suited to its growth, and the seeds from each dealer given the same treatment in every way.

Results.

We are glad to report that with one or two exceptions the vitality (germinating qualities) of the seeds was very satisfactory, about the same per cent. of seeds of each kind from the different dealers germinating, and the products were generally uniform in outline and markings. The varieties sold by the different dealers under the same name generally proved to possess the same characteristics.

* The same varieties, from 7 different dealers.

With the experience gained in this work the past season it is hoped another year that, in addition to similar tests, seeds may be collected from the stock kept on sale in country stores, much of which is produced by growers of little skill, and possibly in localities where mixing by cross-fertilization cannot be avoided. This will entail a large amount of work, a considerable addition to the area of land occupied and much greater expense.

The complete results of the season's test will be presented in tabulated form in a later bulletin.

REPORT OF THE BOTANISTS.

GEORGE E. STONE, RALPH E. SMITH.

The work of this department has followed the plan outlined in the last annual report. Much of our attention during the past year has been devoted to the study of the gall-forming nematode worms affecting cucumbers and tomatoes grown under glass, in the hope of finding some effectual method of combating them. Professor Smith has devoted considerable attention to the study of their life history. The results of the investigations, when completed, will be published in a bulletin.

Most of the correspondence of the department has had reference to plant diseases, although during the summer many inquiries have been received regarding weeds. For the purpose of facilitating their study, we have collected during the past summer about two hundred and fifty species for the herbarium, including several species which have been recently introduced in grass and other kinds of seed. The department takes this opportunity of soliciting correspondence on this subject, as it is desirous of obtaining information in regard to the introduction and distribution of weeds and other plants which may possibly become troublesome.

The Nature of Plant Diseases.

Before passing on to a consideration of some of the plant diseases which have occupied our attention during the past year, it will be well to pay some attention to the nature of plant diseases in general. The diseases with which botanists have to deal can be divided into two classes, namely: first, those which are caused by parasitic fungi, bacteria and similar organisms; and second, those brought about by purely physiological disorders, which have their origin in some ab-

normal condition of the plant, due to improper care and surroundings. While the distinction between the two classes of disorders can in many cases be readily discerned, in other cases it is indeed difficult to discriminate between them, as physiological disorders of the plant so frequently produce just the conditions which are most favorable for the development of parasitic fungi and bacteria. Thus the original cause of the trouble is liable to be entirely lost sight of. Bearing in mind this fact, it must be clear that to recommend fungicides for the treatment of physiological diseases is about as absurd as it would be for a physician to treat a person for consumption who was suffering from malaria or indigestion, and simply required a change in his food or the conditions which surrounded him. The only logical method of treatment under such circumstances is to restore the normal and proper conditions. On the other hand, parasitic fungi which cause serious disorders in our cultivated plants are also found on plants which would pass for quite normal and healthy ones. In fact, probably no plant is entirely exempt from parasites; and here we are brought face to face with the question, What constitutes a plant disease? It may be defined as a disorder caused by any failing in or diversion of the normal physiological actions of the plant. Practically, we include as plant diseases the effects of all of those forms of parasitic fungi which occur on plants, although it is doubtful whether many of them really cause any perceptible harm to their hosts.

Of the two classes of diseases, the parasitic and physiological, those of the latter are more likely to be prevalent in greenhouse plants, inasmuch as the conditions to which the latter are subjected are very artificial, and cannot coincide very closely with those of their normal habitat. The physiological disorders, moreover, are much less likely to be discerned, and, when found, are more difficult to contend with than parasitic attacks, for they are more complicated in their nature, as well as less thoroughly understood. In all our dealings with the plant we must bear in mind that it is a plastic organism, capable of responding, within certain limits, to a great variety of external factors which act as stimuli. These external stimuli are principally to be found

in heat, light, moisture and in the soil conditions. It is therefore the proper application of these factors which the practical grower has to take into consideration, and his success in plant growing will depend largely upon his skill in dealing with them. The minute details connected with the application of light, heat and moisture, the judicious use of fertilizers and the bringing of the soil into proper mechanical condition, are matters which are now commencing to receive some of the attention which they deserve.

Diseases entirely or partially due to Parasitic Organisms.

A Bacterial Disease of the Strawberry (*Micrococcus* sp.?).

During a hot sultry period which occurred in the month of May, 1895, some diseased strawberry plants of the varieties known as the Sharpless and the Belmont were sent to the botanical department from Fitchburg, Mass., for the purpose of determining the nature of the disease and the remedies for the same. The freshly gathered plants showed by their dark-colored, shrivelled leaves that they had been killed outright in the field by some unknown cause.

A careful microscopic examination of the plant proved that there was nothing of an insect or fungous nature to which the trouble could be attributed; but by making more careful observations of the cell contents of the roots and leaf petioles, numerous bacteria (micrococci) were found, which at least indicated a possible cause of the disease.

At about the same time these specimens were received, the disease made its appearance on many of the strawberry plants in the college plats, resulting fatally to the plants in numerous instances, besides leaving others in a dilapidated condition. The variety which suffered the most in the college plats was the Marshall.

In order to ascertain whether the two diseases were identical, and whether the bacteria were the specific cause of the disorder, the organisms were isolated, and a number of pure cultures made in the ordinary sterilized nutrient gelatine. In this medium the bacteria developed quite readily, producing a white, flocculent mass at the bottom of the tube. Its

manner of growth in gelatine proved it to be of an anærobic * nature. From time to time the organism was transferred to fresh gelatine; and during the next fall three varieties of strawberry plants, including the Marshall, Belmont and Sharpless, were transplanted to the greenhouse. After the new plants, which were not especially robust, had made some growth, they were placed in a warm, humid atmosphere, and the roots of a number of plants of each variety were inoculated with the pure cultures of bacteria from the gelatine tubes. As a result of the inoculation, the plants after a few days showed the effects of the disease, some, however, more than others; but in all cases the disease was somewhat milder than in the plants originally affected. An examination of the affected parts of the plant showed the same bacterium, and cultures made from the petioles and roots gave the same characteristic micrococci. Other strawberry plants were again inoculated with the new isolated forms, with corresponding results.

No further experiments in this direction were considered necessary, inasmuch as the effects of the bacteria upon the plants had been ascertained. I will state here, however, that I had never seen the disease previous to this, neither have I been able to detect it since. I consider it one of those sporadic afflictions with which any plant is likely to be troubled, provided just the right conditions are at hand. In this instance the conditions of the weather and that of the plant were especially favorable for such an attack. All of the plants under examination were young, and had not been transplanted a great while; and, furthermore, they had all the appearances of plants which had not become firmly established in the soil. The organism is, not unlikely, a common form of micrococcus which under peculiar conditions is liable to cause some injury. Inasmuch as the primary cause of the disease has its origin in a weakened condition of the plant, and inasmuch as there is every reason to believe that the organism gains its entrance through the root, any attempt to apply fungicides would be useless. The only practical method of dealing with a difficulty of this kind, should it occasionally make its appearance, is to take more pains in

* Not requiring free oxygen.

securing a rugged stock and to keep a more watchful care over the plants during their critical period of transplanting, thus rendering them less susceptible.

A Stem Rot of the Cultivated Aster.

My attention was first called to this disease during the fall of 1895, while visiting the florist, Mr. L. W. Goodell of Pansy Park, who raises a large variety of asters for seed. The specimens obtained from Mr. Goodell were gathered rather late in the fall, when the disease was far advanced, being characterized at this stage of its development by a general blackened and shrivelled condition of the whole plant. Closer observation of the specimen, however, located the point of attack on the stem, close to the root, where the epidermal tissues which surrounded the abnormally hardened wood were more or less disintegrated.

A microscopic examination of the tissues of the affected parts showed a variety of organisms, such as bacteria (micrococci), nematode worms, and such mould-like fungi as Alternaria, Macrosporium and Physarium. Some of these organisms alone might give rise to the disease, but it is more probable that most of them were merely accompanying factors of the diseased conditions to which the plants were subjected.

The bacteria and nematode worms were by far the most abundant, the bacteria especially being widely distributed through the tissues, on that part of the stem adjacent to the roots. Owing to the fact that all of the material at our disposal was in too advanced a stage, it was impossible to arrive at any definite conclusion in regard to the cause of the disease. Since examining the specimen obtained from Mr. Goodell we have heard of the disease as occurring in other places. Among them may be mentioned Mr. Joseph Ammer of Springfield, who writes us as follows: —

Dear Sir: — In reply to your favor of September 21, I am sorry to say that I cannot send you a specimen of the aster plants, because they are all past. The plants appeared to be in a good and vigorous condition up to the time of setting flower beds, when they began to wilt very rapidly, and in a little more than a week a whole bed of seventy-five or one hundred plants was nearly if not

quite gone, save perhaps eight or ten. On closer examination I found that the stock right at the surface of the soil for about an inch appeared soft and pulpy and could be scraped away to the hard heart, which in most cases was black and dead. I could not account for it in any way, unless it was some fungous disease.

There are many others around here who are troubled the same way; some called it lice on the roots, others "aster blight," and let it go at that. The varieties most affected were "Queen of the Market," "Victoria" and the "Comet," while the new "Giant White Comet" was entirely free from it, although separated from the worst bed only by a four-foot path.

If you can suggest any treatment, I should be glad to try it another year, for I dislike to be obliged to give up growing asters, but will have to unless some remedy can be found for the trouble.*

The disease is one that requires further investigation, especially in the field near greenhouses where the asters are grown, in order that the first stages can be more closely observed. The cause of the disease is not unlikely due to some improper method of cultivation; at all events, it is not desirable to recommend any method of treatment until more is known about it. In one instance, when the plants were badly affected in 1895, they were raised in a new field the following season, with the same disastrous results.

In this connection we wish to state that Professor Smith observed some aster plants in a small bed last summer quite similarly affected, but in this instance the death of the plants was undoubtedly caused by a small grub which devoured the roots.

"*Leaf Spot*" *of Decorative Plants.*

We use here the term "decorative" in a special and limited sense, as it is ordinarily used by florists, meaning to include such plants as palms, Dracænas, Ficuses, etc., which are used mostly or entirely for the ornamental effect of the plant as a whole, and this on account of the leaves. Specimens of such plants may be found in almost any florist's establishment, the leaves of which are more or less "spotted;" that is, certain portions of the leaf are dead and withered,

* We attempted to obtain specimens of diseased plants from the Springfield growers, but unfortunately it was so late in the season when the disease was reported from this locality that we were unable to do so, as the affected plants had been destroyed.

and contrast prominently with the surrounding green tissues. Sometimes all the leaves on the plant are affected; again, only a few show any spotting. Sometimes almost the entire leaf is dead; in other cases, only a small spot. Such plants, if at all seriously affected, are of course almost valueless for decorative purposes, and even in less serious cases their beauty is greatly impaired; consequently it is well worth an effort to get rid of such disfigurations, and prevent their reappearance. In order to do this, we must first know the cause or causes of the difficulty. They are extremely various. Any injury, or weakening of the vitality of the plant in any way may produce the effect indicated by the well-known expression "leaf spot." It may be nothing more than a simple burn, produced by the sun's rays concentrated in passing through the glass roof and drops of water on the leaves, or, as frequently happens, by contact of the leaves with the heating pipes. The attacks of insects also sometimes have quite a similar effect. But the trouble is not always so obvious. Various other agencies conspire to produce the effect which we are considering.

It may be stated, as a general principle, that the healthy and rapidly growing plant is the least likely to fall a prey to disease. Exceptions to this may be found in the case of unusually vigorous outbreaks of the most destructive diseases, but in the long run the rule holds good. Let the plant become weak and sickly from improper and insufficient nourishment, too much or too little heat, light, water, etc., poor ventilation or drainage, or any other disturbance of its normal functions, and its liability to disease becomes largely increased. At such a time the weakening of the plant's vitality may proceed so far as to cause a gradual dying away of the leaves and thus produce spotting, or it may, and always does, favor the attacks of parasitic vegetable organisms, most of which belong to the class called the fungi. Such attacks, together with those of bacteria and other vegetable organisms of low rank, are alone properly considered as plant diseases. The fungi are true plants, but of low order and microscopic in size. Some of them are strictly parasites, *i.e.*, they can live only upon the tissues of other organisms. Others, like the toad-stools, are strictly saprophytes, *i.e.*, they live only

upon dead and decaying organic matter. These are entirely harmless to plant life. Still others, while ordinarily saprophytes, have parasitic tendencies, and may attack plants in a weak and unhealthy condition. A sickly or injured plant may be attacked by a variety of such forms, together with true parasites, bacteria, insects and other organisms both of the animal and vegetable kingdoms, making it impossible to say which was the original cause of the trouble, if, indeed, any one of them could be strictly considered as such.

A leaf spot produced by fungi is a place on the leaf where a fungous plant has become established and consumed the vital substance. The spot becomes larger as the fungus grows out into new tissue. Fungi reproduce themselves by *spores*, corresponding to the seeds of higher plants. These spores are of course extremely minute, and are produced in infinite numbers. They are smaller than the finest dust, and float about in the air with the greatest readiness.

In the treatment of fungous diseases only one course of action can be successful. This is *prevention*. A leaf once infested with a fungus can never be restored to its normal condition, for not only is the fungus within its tissues and out of reach of any treatment, but, furthermore, certain parts of the leaf are already dead, and can never be restored. One method of preventing such diseases is by killing the spores before they can germinate. The now common operation of *spraying* consists in applying to plants affected or liable to be affected by disease certain substances diluted with water to a strength sufficient to destroy the fungous spores but not injure the leaves. This solution is applied in the form of a fine spray, by means of a pump and nozzle. The application of this method is now well established in the treatment of most of our destructive plant diseases, especially those affecting fruits and vegetables. The most effective substance thus far discovered for spraying purposes is the so-called Bordeaux mixture, — a sort of blue whitewash, made by combining lime with copper sulphate (blue stone, blue vitriol). Many other substances have been tried, some with great success; but the Bordeaux mixture is still the most satisfactory for general purposes, for it kills the spores, sticks to the leaves and does not injure the plant.

But in the case of decorative plants, even if the Bordeaux mixture effectually prevented disease, its use would involve a serious disadvantage. Imagine a fine palm or Ficus covered with blue whitewash! It would certainly be more disfigured than by any disease. We have, however, other fungicides which have given very satisfactory results in the treatment of plant diseases, and which, being clear solutions, leave no stain on the plant. Among these the so-called ammoniacal copper carbonate solution is one of the best. It is prepared by dissolving one ounce copper carbonate in strong ammonia (26°), of which about one pint will be required. The copper carbonate should be put into a wooden pail with sufficient water to make a thick paste, and the ammonia then added. The resulting solution is then diluted with about nine gallons of water.

But, aside from any method of spraying, much can be done for the eradication of spot diseases by removing and destroying all affected leaves, etc. This must be done promptly and thoroughly, in order to be effectual. As soon as a leaf is seen to be spotted, it should be removed and *burned*. This will certainly lessen the extent of the disease, and will in many cases entirely eradicate it, if the plant be kept in good growing condition. We would recommend, however, that all plants which have been or are liable to be attacked by such diseases should be sprayed with the above-described solution, the frequency of the operation varying with circumstances. A plant which has been diseased should be sprayed three or four times, at intervals of about two weeks. If then no further indications of the disease appear, spraying may be discontinued altogether, or the whole house may be thoroughly wet down with the solution every month or two, as a general precaution. (If the house contains any particularly delicate or valuable plants, it may be well to try the solution on a small scale on them before applying it generally. We have experimented with quite a variety of common greenhouse plants, and have experienced no harmful results. The solution should be diluted to the full extent recommended.) Spraying apparatus can be obtained of any dealer in agricultural implements.

But, after all, the perfection of spraying methods, however

successful, is not the *ne plus ultra* of the science of growing plants. We would not in the least disparage the most exceedingly valuable results of the work done by experiment station workers and others in this direction. There can be not the slightest doubt that millions of dollars' worth of fruit and vegetables have been and will continue to be saved from destruction by this means. But the fact remains that success in growing plants, as in every other direction of human industry, comes not from the observance of any laid down rules and formulas, but rather is the reward of long experience, close application and intelligent skill. The triumph of the gardener's art is the plant brought to perfection in a natural, normal and healthy manner, and not that which owes its existence to skill in doctoring.

We will now briefly describe a few leaf-spot diseases which have come to our notice and which have received little or no public mention. The treatment which we have recommended will apply of course to these and any other similar diseases.

A Leaf Spot on Ficus elastica (India Rubber Plant).

(*Leptostromella elastica*, Ell. and Ev.).

The rubber plant, which is used quite extensively for ornamental purposes, on account of its large, dark-green leaves, is not often attacked by disease. In our own houses and also in other places in this State we have, however, recently found plants affected by a serious spotting of the leaves. The first indication of the disease is seen in the leaf's turning in small spots or streaks, which rapidly increase in extent, changing from yellow to a brownish color and finally to an ashy gray, when the affected portion is quite dead. At this stage the spots may include a large portion of the leaf or only a small part of it. There is often more than one on a leaf, but never a large number. The dead portion is sharply distinct from the living, and banded by a narrow black margin. Upon its surface little black dots appear, which are cavities containing the spores. The spots keep increasing in extent, until the leaf finally loses its vitality and falls from the plant. No plant more than ficus shows the effect of such a disease as this, since its handsome, dark-green leaves are its only ornamental feature.

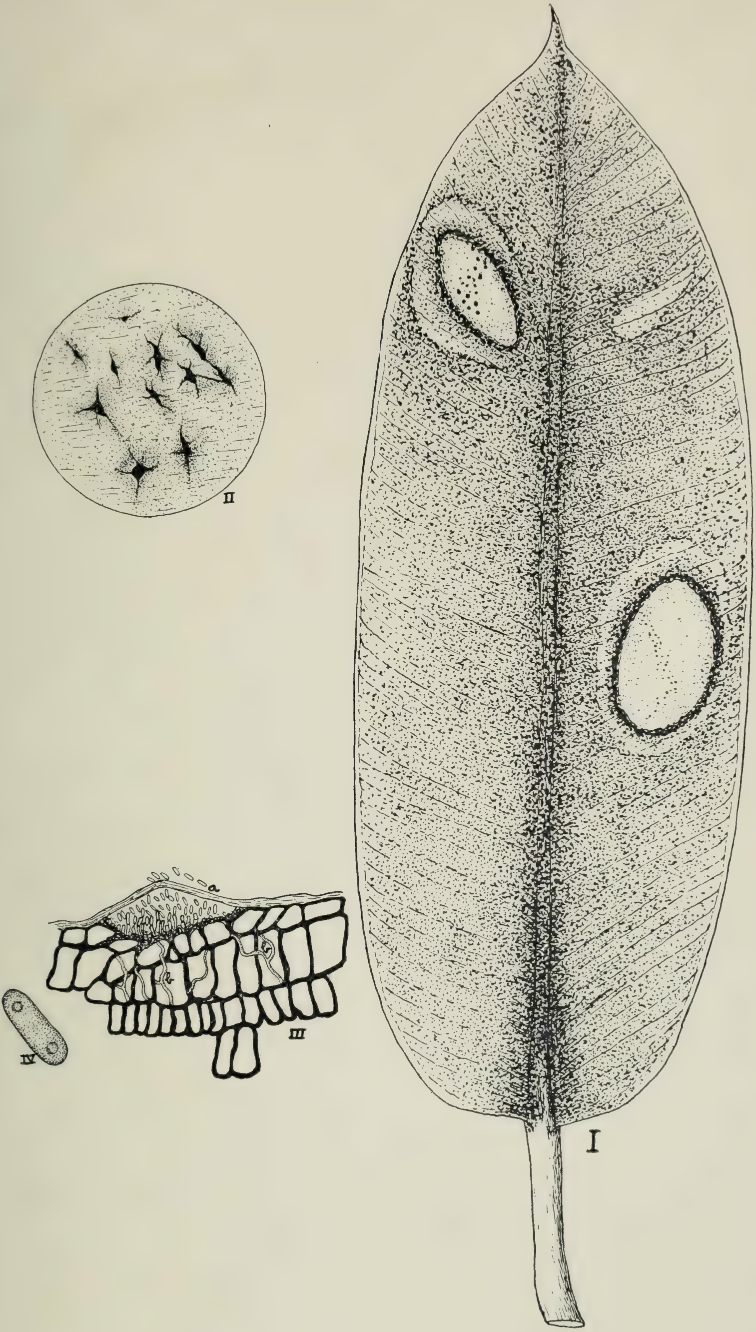

Figure 1.

I. Leaf of Ficus Elastica with spots caused by *Leptostromella Elastica.*

II. Surface of dead area enlarged, showing spore bearing cavities.

III. Cross section of dead area with spore cavity at *a* and filaments *b*, running among the cells of the leaf.

IV. A spore x 1300.

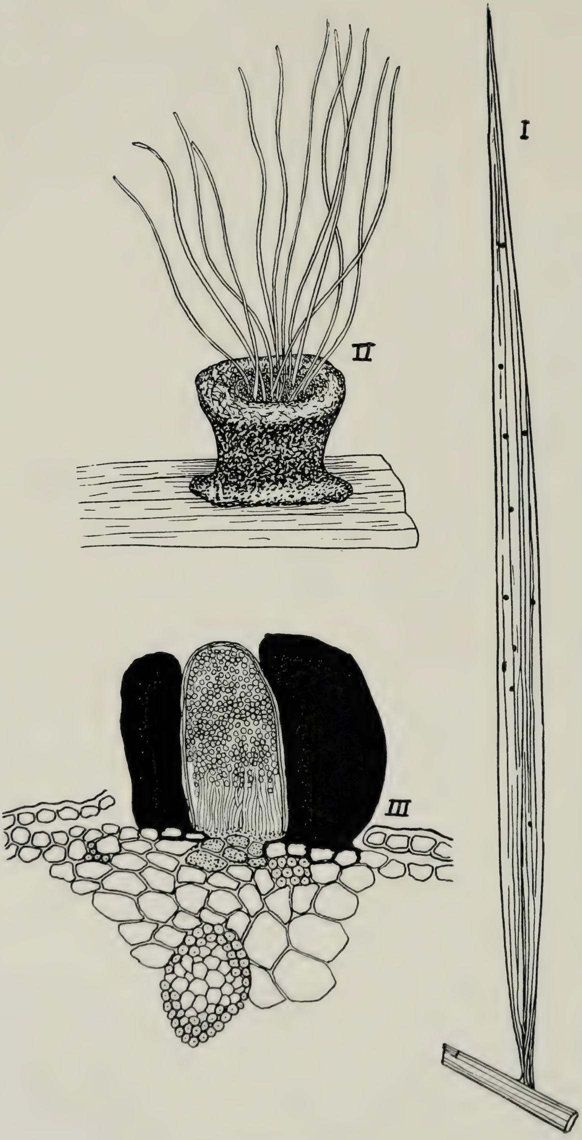

Figure 2.

I. Leaf of Phornix Canariensis attacked by *Graphiola Phornicis.*

II. Spore bearing conceptacle enlarged.

III. Section of a conceptacle full of spore, and portion of the leaf.

This disease was first brought to notice by Prof. F. L. Scribner, in "Orchard and Garden," January, 1891, and scientifically described at about the same time by Mr. J. B. Ellis, from specimens sent by Professor Scribner. We find no mention of it since that time, which seems to indicate that it is not generally prevalent. Should it become so, it cannot fail to become very troublesome, for it spreads with considerable rapidity, and has a ruinous effect upon the decorative value of the plant. It was introduced into our houses, apparently, on a variegated-leaved Ficus elastica purchased from an outside florist. From this plant it spread to others of the ordinary green-leaved type, and has practically ruined several fine specimens. Great care should therefore be taken, in purchasing stock outside, that it be free from disease. (Not infrequently we hear of Ficus plants whose leaves turn yellow and drop off. This marks the normal end of the existence of the leaf, or, if it occurs extensively, an unhealthy condition of the plant, and is not to be confused with the fungous disease. An effect almost exactly similar, superficially, to that of the latter, is sometimes produced by sunburn.)

A Leaf-spot Disease of the Date and Similar Palms (*Phœnix* sp.).

(*Graphiola Phœnicis*, Poit.)

This disease is by no means a new or unknown one, but it has received little attention from an economic stand-point. It attacks various species of Phœnix in cultivation, and injures and disfigures them to a considerable extent. The affected parts of the leaf become mottled with yellow, and upon the surface little black eruptions appear, which are cup-shaped conceptacles produced by the filaments in the interior of the leaf, and in which the spores of the fungus are produced. These little eruptions are about one-fiftieth of an inch high and twice as wide, — plainly visible, therefore, to the eye. They consist of a firm, dark-colored exterior layer, enclosing a more delicate inner covering, which contains a mass of thread-like filaments on which the spores are produced. The leaf becomes thickly dotted over on both sides with the conceptacles and slowly shrivels away and

dies, innumerable spores being produced meantime, which are ready to attack new leaves and plants. A fair-sized plant of Phœnix canariensis, sent in for examination and treatment, was found to be badly affected with this disease, and was treated as recommended above. All leaves which showed any sign of the disease (which included all the larger leaves of the plant) were cut off at the base. The plant was then sprayed, and has since developed new leaves which show no sign of the disease, though it is now nearly a year since the plant was received.

A Leaf-spot of the Begonia.

While it may be questioned whether the value of the begonia is strictly that of a decorative plant, in the sense in which we have been using this term, still, it cannot be denied that the plant is often used for this purpose, and on that ground we will consider in this category a spotting of its leaves which has come to our notice. Ordinarily the begonia is seldom affected by disease, insects or any other injurious agency. Still, it is not invulnerable, and we find occasional reports of diseased plants. In the English journals, "The Garden" and "The Gardener's Chronicle," a discussion runs along through several numbers in 1895, concerning a so-called "begonia rust," which seriously affected tuberous begonias. This, however, was finally settled on good authority to be insect work. "Damping off," a fungous disease of begonia and many other kinds of seedlings, is not uncommon. Professor Halsted of the New Jersey Agricultural Experiment Station mentions two leaf-spot diseases of begonia in the "American Florist," September, 1894, one caused by nematode worms, the other a fungous disease.

During the past year or two we have met with a definite spot disease on begonias, mostly of the tuberous variety, which is quite prevalent in our houses and those of a neighboring florist. We are not yet entirely certain as to the cause of the difficulty. The spot begins either on the margin or interior of the leaf, and slowly increases in size until the leaf dies and drops off. There are sometimes several spots on each leaf. As they increase in size their surface is

Figure 3. — Spotted Begonia leaf.

marked by concentric curved lines parallel to the edge of the dead portion, as in many spot diseases of fungous origin. Microscopic examination, however, shows nothing which may with certainty be decided upon as the cause of the trouble. We usually find fungous filaments and spores, but they are of many different species, and mostly moulds of a saprophytic or only partially parasitic nature, and cannot be regarded as the primary cause of the disease. In a few specimens we have found the spore-bearing conceptacles and spores of a fungus belonging to or near the extensive parasitic genus Glœosporium, which includes a great number of leaf spots. We consider this as the probable cause of the disease, but the spore-bearing material was very scanty, and we were unable to identify it with any described species. Possibly the trouble may be due to various causes, not all of a fungus nature, but appearances seem to indicate that there is a definite disease which causes most of the spotting. At all events, it will be a wise precaution, in this and all similar cases, to remove and burn all affected leaves.

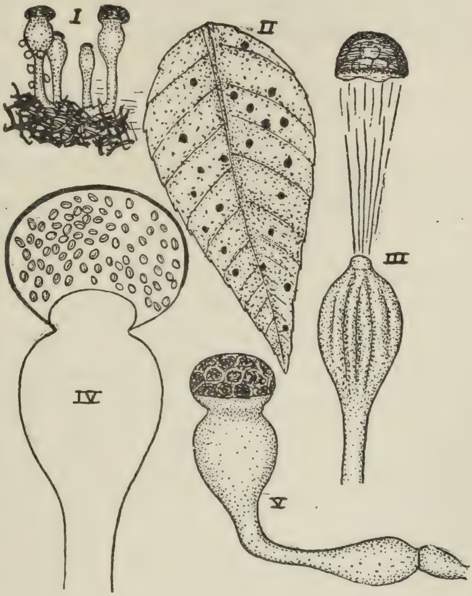

Fig. 4.—Pilobolus crystallinus, Tode.

I. Somewhat enlarged.
II. Sporangia on rose leaflet.
III. Discharge of sporangium.
IV. Section of sporangium and filament, showing spores.
V. Sporangium upon filament before being discharged.
III., IV. and V. are greatly enlarged.

Several other leaf spots of the palm, dracæna, ficus and other decorative plants have come to our notice. Some were only simple sun-burns, while others were real fungous diseases. What was at first thought to be Leptostromella elastica (the above-described leaf spot on Ficus elastica)

upon Ficus religiosus, the banyan tree, proved to be simply a sun-burn, though its superficial resemblance to the fungous disease was most perfect. Quite a serious and apparently new spot disease of greenhouse orange trees has been met with, which is of true fungous origin. It is not necessary to describe all these forms in detail, as the treatment is practically the same in each case.

A So-called Black Spot of the Rose.

(*Plilobolus crystallinus*, Tode.)

It is not unusual to find rose bushes in the greenhouse thickly dotted over with little black specks, appearing not unlike "fly specks," which occur on all parts of the plants alike, and of course greatly disfigures the blossoms. Microscopic examination shows each speck to be a minute sac, filled with what are evidently fungous spores. It would thus appear that we had here a fungous disease, and as such it has been described under several different names. In fact, however, this is in no sense a disease, and the little sacs of spores have no real connection with the rose plant, being attached to it simply by cohesion. The sacs of spores or *sporangia* are produced by a fungus, Pilobolus crystallinus, which is strictly saprophytic, and grows on decaying manure. As such manure is usually placed upon the soil under roses, spores of the Pilobolus are introduced in it, and find a favorable place for development. They produce the thread-like filaments which make up a fungous plant, and on the ends of certain of them sporangia are developed. The filament behind each sporangium becomes filled with a watery fluid, which gradually increases in quantity, and exerts a pressure on the sporangium at the end. This pressure becomes so great that finally the sporangium, at about the time of its maturity, is forced from the end of the filament with sufficient power to send it a considerable distance. We have seen them on the roof of a rose house at least eight or ten feet from the soil where they were produced. Striking a plant, they adhere to it, and give the appearance of having developed there. We find them particularly on the rose, simply because the practice of covering the soil with manure is confined to the cultivation of that plant.

While this is not a disease in any sense of the word, still, the effect of the fungus on roses is of course disastrous to their beauty and salability. Knowing that the disfiguring sporangia come from the manure, where they can readily be seen in the morning in process of development, it would seem a comparatively simple matter to destroy them at that stage, either by mechanical means or by spraying with a fungicide.

A Leaf Blight or Anthracnose of the Cucumber.

(*Colletotrichum Lagenarium* (Pass.), E. and Hals.)

During the past summer we have received specimens of cucumber leaves from several different parts of the State, which were infested with a very destructive blight. In Arlington and Leominster, where the raising of hot-house cucumbers is carried on extensively, the disease was reported as doing great damage. The fungus which causes this trouble grows within the tissues of the leaf, and by sapping its vitality causes its death. Under favorable conditions it is very quick acting and extremely destructive. The infested leaf first shows yellowish spots upon its surface, which rapidly increase in size and become dry and dead. Various moulds often develop upon the dead areas, and, being more prominent than the fungus which really produces the disease, appear to be the cause of the trouble. A dark-brown, luxuriantly growing species of Macrosporium or Alternaria was particularly abundant upon the specimens received this summer, and had evidently been taken to be the cause of the disease, which was referred to as the "brown mildew," "brown leaf blight," etc. Such growths undoubtedly hasten the destruction of the leaf, but they are able to develop only upon leaf tissue which has been killed or greatly weakened by the other more strictly parasitic fungus which is invisible to the eye. The dead areas gradually fall away, leaving large irregular holes in the leaf, which in a short time becomes entirely dead. The same fungus often attacks the fruit, causing it to rot badly, and has been proven to be the cause of the well-known "rust," so called, of the pods and leaves of the bean. It also attacks the watermelon, musk-melon, citron, squash and pumpkin, affecting both leaves and fruit. We have recommended spraying every week or two with the

Bordeaux mixture for this and one or two other somewhat similar cucumber diseases, and have received reports from Arlington of favorable results from such treatment. While this is a most destructive disease if left unchecked, it ought nevertheless to be kept under control with comparative ease if judicious spraying with any good fungicide be combined with proper management of the crop.

An Unusual Outbreak of Two Rusts.

The Asparagus Rust (*Puccinia asparagi*, D. C.).

The rust of the asparagus has been known in Europe for more than half a century, and has caused more or less damage there. In this country it has been known for several years, but not at all extensively. During the present season, however, asparagus beds in various parts of this State, in New Jersey and doubtless in other States, have been seriously attacked by this rust, and are threatened with great injury should it continue to develop extensively from year to year. This fungus is one of the true rusts, and is quite similar to that attacking the wheat. Like it, there are three distinct stages of development, in each of which a different kind of spore is produced. According to European accounts, the rust first appears on the asparagus in the spring, at which time it produces the first kind of spores, the *æcidia*. These develop in turn during the summer, and produce the spores of the second or red-rust stage, the *uredo* spores. These again develop, and produce spores of the third or black-rust stage, the *teleuto* spores, which lie over winter and in the

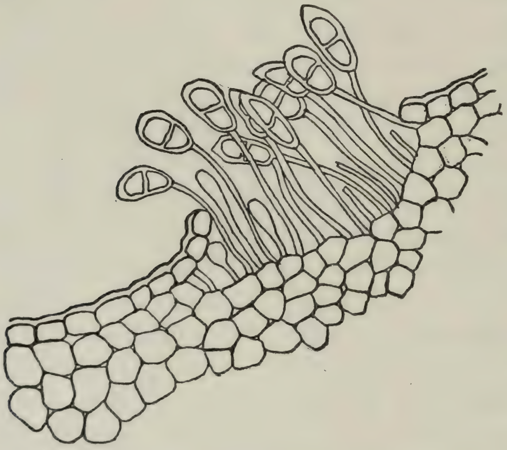

Fig. 5. — Section of a cluster of teleuto spores of *P.* asparagi, greatly enlarged.

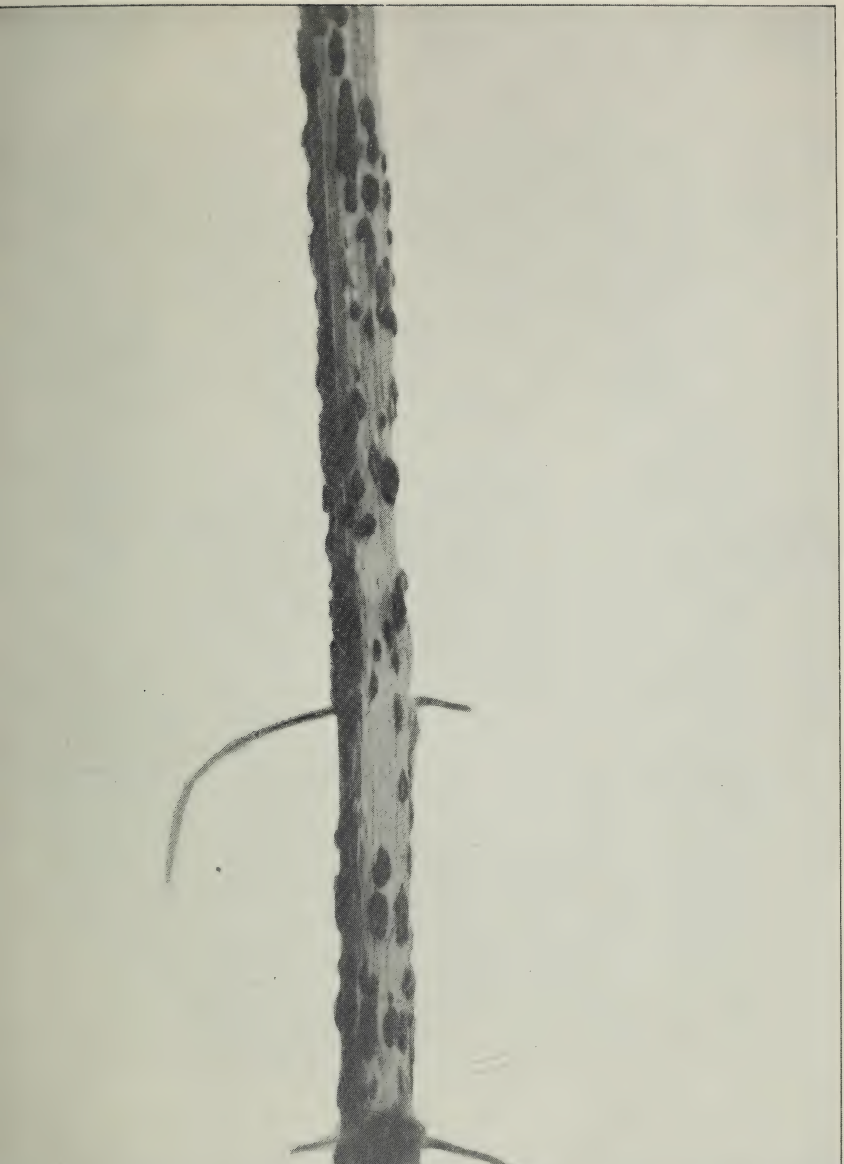

Figure 6. — Asparagus stem with rust.

spring attack the asparagus again, and produce æcidia. In each stage the fungus consists of minute filaments, which grow in the tissue of the plant and draw their nourishment therefrom. In some rusts one of the stages is most prominent, in others it is another. In the wheat rust the uredo or red-rust stage is perhaps the most conspicuous. In the present case the black or teleuto spores are most prominent. They appear in October and November, when the affected plant becomes thickly covered over with small, irregular black lines and blotches, which are the masses of spores pushing out through the surface. This is the stage which has been observed this fall in Massachusetts and New Jersey. Doubtless the other two stages were developed during the season, but did not become sufficiently prominent to attract attention.

Since this disease does not become prominent until late in the fall, and the asparagus crop is gathered in May and June, a question naturally arises as to how it can have any serious effect. There is indeed no great danger to be apprehended of its actually disfiguring the marketable product; but no plant can undergo a continuous and vigorous attack of a parasitic fungus without a serious loss of vitality, if it be not killed outright. If this rust appears only intermittently and not extensively, its ravages need not be seriously feared; but, should it continue to develop in the present abundance year after year for any considerable time, it cannot fail to become a most serious obstacle to the raising of asparagus. Moreover, we have examples in similar rusts, like that of the hollyhock upon its first appearance in Europe and later in this country, which have developed with unusual vigor and destructiveness immediately after their first outbreak in a new locality and climate. The raising of hollyhocks in Europe was well-nigh impossible for some time after the introduction of the rust. The progress of this asparagus rust is therefore worthy of close attention and some apprehension. Meantime, attempts should be made to check it as much as possible by cleaning up the bed in the fall and burning the infested tops, thus destroying countless numbers of spores. This should be done as early as possible, before the spores shall have become mature and scattered by the wind.

A Late Rust of the Blackberry (*Chrysomyxa albida, Kühn*).

This rust, like that of the asparagus, has been long known in Europe, but only comparatively recently observed in this country. It was first brought to attention in America in 1886, but, while it has been not uncommon since then, it has never assumed any economic importance. Very likely it has been more or less confused with the spring orange rust (Cæoma luminatum, Lk.), which it slightly resembles, and on that account has escaped particular mention ; still, it is hardly probable that it has been generally prevalent. In the season of 1894, however, it became decidedly abundant in our plantations, and caused considerable apprehension. It was also reported from other parts of the State, and threatened to become a serious matter. In 1895 it appeared again, but not so abundantly as in the previous season ; and this year its attacks have been very slight, so that there seems to be no ground for fear of danger from this source at present.

Description. — This has been called the *fall* rust, to distinguish it from the *spring* rust, which appears much earlier in the season, and is entirely distinct. The latter is a well-known disease to fruit growers, as it causes much damage and has been the subject of many experiments and published articles. It attacks both blackberries and raspberries. Chrysomyxa albida comes on later, appearing in August and continuing through the fall. It does not attack the raspberry. It is one of the true rusts, having the three kinds of spores, as in the asparagus rust. In this case, however, it is the æcidia and uredo spores which are most prominent. These appear in small, powdery, scattered, bright orange-red spots on the under side of the leaf, and are consequently not as prominent as the indications of the asparagus rust.

While the same conclusions as to the future may be drawn in this case as in that of Puccinia asparagi, still, the results of three years' observation on the blackberry rust indicate that we have no great cause for alarm in that direction ; while in the other case, having no such definite knowledge, we cannot but feel somewhat apprehensive until time shall show what is to be the result.

The Tomato Mildew (*Cladosporium fulvum*, Cke.).

The disease which is commonly called mildew is without doubt one of the greatest obstacles to success in growing tomatoes in the hot-house. While it does not always kill the vines outright, still, its effect in weakening their vitality and reducing their yield is a most serious one. We have received specimens of tomato leaves affected by this disease from several different localities, and have observed it in greater or less abundance in almost every house of tomatoes which we have examined. It also attacks tomatoes grown out of doors, but by no means so generally as in the hot-house.

When this disease comes on, there appear on the lower surface of the leaves brownish, felt-like spots of irregular shape and various sizes, which rapidly increase in extent, until the whole leaf finally turns black and withers away. It does not always spread so rapidly and kill the leaves at once, but is often found only on the lower leaves, or in spots which do not increase rapidly in size. Nevertheless, it is constantly weakening the plant, and, let a favorable opportunity come, as come it will sooner or later, and it spreads through the house with great rapidity and destructiveness.

The fungus consists of a dense mass of thread-like filaments, which ramify through the leaf in all directions and more or less upon its surface. The felt-like areas on the under surface of the leaves are composed of a mass of spores and the filaments which produce them. The spores germinate readily in water, developing filaments similar to those from which they were derived. This species belongs to a group of fungi which are mostly moulds and mould-like forms, growing upon dead vegetable matter or plants in a weak and unhealthy condition. This mildew is especially active in attacking such plants, upon which it produces the above-described disastrous effect. Its development is also greatly favored by excessive moisture in the air, *i. e.*, a "muggy" atmosphere, which indeed is favorable to the development of most plant diseases. The tomato requires a considerable heat for successful growth in the hot-house. If, while the plants are growing rapidly, the temperature

suddenly falls from any cause and they consequently receive a check in their growth, it will be a most favorable time for an attack of the ever-ready enemy, the mildew. Poor ventilation and partial exclusion of sunlight by crowding the vines too close together will produce a muggy atmosphere, and have a similar result. To prevent crowding, it is advisable to trim up the vines somewhat and train them to trellises or single stakes. Uniform heat, good ventilation and free access of air and sunlight to all parts of the plant will prove the most effective preventive of mildew. In our climate, however, the first two conditions are liable to prove antagonistic to each other; for in cold, windy weather it is impossible to ventilate the house without greatly reducing the temperature.

Spraying with the ordinary fungicides has proved effectual in preventing this disease. The spraying should be done about once in two weeks, commencing when the plants are quite small. It is also a wise precaution in all hot-house work to thoroughly clean up and burn all dead leaves, vines and similar materials when a crop is removed, and, if possible, fumigate the house with sulphur. The latter of course cannot be done if there are any plants growing in the house.

Too often we find that such diseases as this are allowed to develope in the house, with no effort being made to check them. So long as the plants are not killed outright, many growers seem to think that no damage is done. This is certainly not the case, for the presence of the fungus is a constant drain upon the vitality of the plant, reducing its yield both in quantity and quality. The practice of spraying, which can be done at an insignificant cost per plant, will, if properly carried out, prove both effectual and profitable.

A Crysanthemum Rust.

Specimens of diseased chrysanthemum leaves which have been sent in to the station for examination prove to be affected with one of the true rusts, the first, so far as we know, to be reported upon this host. The specimens were sent by Mr. Geo. H. Hastings of Fitchburg, Mass., who writes as follows: —

The "rust" is quite common on the chrysanthemum leaves. In the advanced stages it completely kills the leaf. It seems to me that it is a very bad enemy to fight. I had plants enough to bring seventy-five or a hundred dollars worth of flowers, and I would not sell one flower, as I did not wish to have the name of selling such flowers. The plants were grown in the garden and "lifted" about the middle of September. The rust was on the leaves at that time, and some of them were dead.

The rust was in the uredo or red-rust stage, and proved to be a form closely resembling and probably identical with Puccinia Tanaceti, S. (P. Helianthi, D. C.), which occurs commonly upon Tanacetum vulgare (tansy), several species of Artemisia (ragweed) and Helianthus (sunflower), and several other related plants. Upon these plants it sometimes acts most destructively, as it has done in this instance upon the chrysanthemum. It bids fair to become a serious obstacle to the cultivation of this valuable flower.

Experience has shown that in the development by cultivation of any plant, as it becomes changed more and more from its natural form and forced into an abnormal development, its power to resist the attacks of disease becomes diminished. For this reason reports of new diseases upon our various cultivated plants are of frequent occurrence. All such diseases are certainly not new in the sense of being caused by a kind of organism which never existed before, but only new upon some particular kind of plant, which has, by reason of its forced and abnormal development, lost the power to resist the attacks of the parasite, which has existed all along upon some other kind of plant, and very likely in a milder form.

The chrysanthemum in its present form is a comparatively new plant in this country. Its great popularity has led growers to make extraordinary efforts to force its development along certain lines, notably in size of flowers. The production of flowers eight inches in diameter by a plant destined by nature to produce them less than quarter that size cannot be accomplished without bringing about serious changes in the vital functions of the plant, and making it more susceptible to disease. Therefore the list of chrysanthemum diseases may be expected to gradually increase, as

it is now doing. At least two have been previously known. *The leaf spot* (Septoria sp. and Phyllostica sp.) was first described by Professor Halsted of the New Jersey Experiment Station several years ago, and occasions more or less damage. *The mildew* (Erysiphe Cichoracearum D. C.) has appeared more recently, and is rapidly increasing. This has a history very similar to that of the rust under consideration, being very common on Helianthus and Artemisia, as well as many other plants.

We can make no definite recommendations at present as to a treatment for this rust, it having been reported so late in the year. The true rusts are notoriously difficult to combat; the most so, perhaps, of any class of diseases. Many methods of treatment have been tried, but few with decisively profitable results. That panacea of plant diseases, the Bordeaux mixture, has been frequently recommended and tried for various rusts, with widely varying results. The same can be said of another common fungicide, the ammoniacal copper carbonate. Stewart, of the New York Experiment Station, reports, in the case of the carnation rust (Uromyces Caryophyllinus (Schrank) Schrt.), that a solution of potassium sulphide, one ounce to one gallon of water, was most effective. This strength might injure chrysanthemum leaves. One ounce to four or five gallons of water would be safer, but not, of course, as effective. With the hollyhock rust (Puccinia Malvacearum, Mont.), a very destructive disease, Mr. H. L. Frost of Arlington informs us that he has tried the Bordeaux mixture and also the commercial fungicide called "Fostite," with results in favor of the latter. It is possible, then, that some of these substances may be effective in preventing this chrysanthemum rust, but we cannot vouch for it. It would certainly be advisable to spray the plants occasionally with the Bordeaux mixture or with potassium sulphide, *commencing in the summer, when they are young and before any disease appears.* If the plants are healthy when put into the house, one or two sprayings thereafter should be sufficient to carry them through the season. All plants known to be diseased should be removed and burned.

We would urge any grower who has been troubled with

any disease of his chrysanthemums to carry on a series of experiments with various fungicides, in order to get at some idea of the best method of treatment. Without such co-operation on the part of the grower we can do but little toward remedying such a disease as this, which does not occur everywhere, and consequently can only be experimented upon wherever it may happen to break out. The same is true with many other diseases, especially those affecting various hot-house plants. If we could plant chrysanthemums and be sure of getting rust, mildew and leaf spot, and similarly with other plants, if we could be sure of getting all their diseases, then our opportunities for experiment would be unlimited; but such, of course, is not the case. While some diseases are very general, many others appear only here and there, and the opportunities for experiment are limited to those places. We will gladly aid any one as much as possible in carrying on such experiments, and will give them our personal attention so far as we may be able.

"*Drop*" *of Lettuce.*

This disease has been for the last few years the most difficult one with which the lettuce growers about Boston have had to contend. Some growers always have a large number of plants attacked, while others have it so badly that they frequently lose half the crop. The annual loss to the lettuce growers about Boston from this disease alone amounts to several thousand dollars. The effect of the disease shows itself in a single night, and it is not very difficult to detect, inasmuch as the whole plant simply collapses. It not only makes its appearance on the young plant a few weeks old, but on the mature ones as well. Lifting the diseased plant out of the soil, it shows at once that the trouble is localized in the soft, rotten stem, which is not unusually covered with fungous growths sufficiently thick to be seen with the naked eye. Examination made with the microscope reveals the presence of numerous fungous filaments ramifying throughout the stem and root. The organism causing the disease is a species of damping fungus (Botrytis), which has previously been described in the ninth annual report of this station.

Practical lettuce growers resort to various methods in order to contend with this foe, but none of them have proved wholly effectual. Most of them recognize the fact that the source of contamination is largely in the soil, and that the disease is much more troublesome in old soil than in new. This is what might be expected, especially when the old decomposing roots are left in the soil, as they often are, thus offering the most favorable conditions for the spread of the disease. As a means of controlling it, some growers have resorted to changing the soil, with beneficial results; while others make a practice of covering the surface with a layer of pure sand or yellow subsoil, about one inch in depth. The burning of sulphur in the house before a new crop is set is also practised, and this might be expected to kill the spores with which it comes in contact; but it is very doubtful whether the sulphur affects the spores in the soil to any great extent. It appears, however, that sulphur penetrates the soil somewhat, and, on account of the injury which young plants are known to receive from sulphur, they should not be set for a few days after it is used.

The disease appears to be more common than formerly, and this is partially due to the practice of running high night temperatures. The collapse of the plant is most likely to occur during the night, and with a lower night temperature — for example, one not exceeding 38° to 40°F. — the trouble would no doubt occur less frequently. The opportunities for treating the soils with chemicals do not appear to us to be very promising, for the reason that solutions which would be likely to cause the death of the fungus would have to be used in very large quantities, as well as much stronger than in ordinary cases, and they would be likely to cause injury to the crop. My experiments in applying a great variety of chemicals to the soil have shown that, while a comparatively weak solution accomplishes all that can be desired in the laboratory, when applied to the soil the effect of even much stronger solutions more copiously applied is radically different. So long as the tendency is to force crops more and more, it must be expected that the gardener will have numerous abnormal conditions to contend with.

No doubt the most successful and I believe the cheapest

method in the long run would be to apply heat as a remedy for fungus and other pests in the soil. I have used a great many pots of earth heated with steam up to 130° to 200°F., with the most beneficial results, not only in the subsequent growth of the plant, but also in destroying the troublesome pests which infest the soil. The soil under glass could be easily fitted up with a system of irrigating tile, which could be used not only for purposes of irrigation, but also for forcing steam through them and partially sterilizing the soil. I have not as yet had an opportunity of treating this fungus with heat, but I should suppose that, if the soil was heated to 200° F., it would result in its death.

Physiological Disorders.

Wilt of Maple Leaves.

Last May a number of maple leaves in a dry and crispy condition were sent to this department from various parts of the State, under the supposition that they were affected by some form of fungus or insect life. Examination of the leaves, however, by Mr. Robert A. Cooley of the insectary, showed that no form of either of these organisms could be found. All of the leaves that were sent in were those of the sugar maple (Acer saccharinum), although the same condition was observed in a large number of different varieties of Japanese maple growing on the college grounds. Moreover, they showed the wilt only on one side of the tree, namely, the west, that being the direction of the prevailing wind the day upon which they were affected; and this peculiarity — so far as could be learned — was the same all over the State. This phenomenon is especially interesting, as it occurs on apparently healthy trees under certain exceedingly unusual conditions, — conditions, too, which, lasting only a few hours, are yet capable of giving rise to abnormalties of function. We attribute the wilting of sugar-maple leaves, which occurred quite generally throughout Massachusetts on May 18, to an excessive transpiration or evaporation of water from the leaves, at a time when the water supply of the roots was extremely limited. This was brought about by a remarkable combination of meteorological conditions favorable

to this result. It is well known to vegetable physiologists that agitation of the leaves of a plant greatly accelerates the process of transpiration, that is to say, the evaporation of water from the leaves. It is also well known that transpiration is accelerated by light, a low relative humidity and a high temperature. Such were just the conditions upon May 18.* During the months of April and May the rainfall was far below the normal, while the long-continued drouths of the two preceding years will be well remembered. Thus it is evident that the supply of water available to vegetation must have been much less than usual, and under the unusually strong, dry and warm wind of May 18, the leaves of a tree like the maple, with its large leaf surface, might be expected to become greatly exhausted and wilt badly. When this wilting was not carried to excess the leaves recovered; when, however, it went too far, it resulted in a dying and subsequent shrivelling of the foliage.

Another factor which must not be overlooked in accounting for this disorder is the maturity of the foliage. Young leaves always give off the greatest amount of water, and the maple leaves in May are giving off their maximum quantity.

With plenty of water in the soil these high winds would not have caused any wilting; or, if the same conditions had ensued during August or September, when the foliage was more mature, less wilting would have resulted. The west side of the trees, being the side exposed to the prevailing winds, was the most severely affected.

Top-burn of Lettuce.

A disease occurring on greenhouse lettuce, and characterized as "top-burn" came under our observation the past winter. The disease can readily be distinguished by the withering and subsequent turning back of the tip and margin of the outer leaves, the blackened area sometimes extending inwards an inch or more from the margin. This feature greatly disfigures the plant and consequently affects its

* Meteorological conditions were as follows: total precipitation, April, 1896, 1 32 inches; April, 1895, 5.60 inches; May 1–18, 1896, .16 inch. May 18, maximum velocity of wind 71 miles per hour; relative humidity, 47.31 (average for May, 62 5); number hours sunshine, 13 (in possible 14½); maximum temperature, 84°.

market value, but the real damage to the lettuce plant is never sufficient to destroy it. Microscopic examination of the blackened areas frequently shows bacteria in the cells, but more often the "damping fungus" (Botrytis) is present, and can be readily observed with the naked eye. In this instance, however, neither of these forms of organisms has anything to do with the cause of the disease. They are simply accompanying factors, which are always ready to seize upon any abnormal condition in the plant which is especially favorable to them. The disease is a physiological one, and has its origin in the unfavorable surroundings of the plant, especially those connected with transpiration and sunlight. Mr. B. T. Galloway of the United States Department of Vegetable Physiology and Pathology has made this disease a study, and I can do no better than to quote his views: —

Top-burn, one of the worst troubles of the lettuce grower, does comparatively little injury on this soil [Boston soil], providing the proper attention is given to ventilation and the management of the water and heat. Burn is the direct result of the collapse and death of the cells composing the edges of the leaves. It is most likely to occur just as the plant begins to head, and may be induced by a number of causes. The trouble is most likely to result on a bright day following several days of cloudy, wet weather. During cloudy weather in winter the air in a greenhouse is practically saturated, and in consequence there is a comparatively little transpiration on the part of the leaves. The cells, therefore, become excessively turgid, and are probably weakened by the presence of organic acids. When the sun suddenly appears, as it often does after a cloudy spell in winter, there is an immediate rapid rise in temperature, and a diminution of the amount of moisture in the air in the greenhouse. Under these conditions the plant rapidly gives off water, and, if the loss is greater than the roots can supply, the tissues first wilt, then collapse and die. The ability of the roots to supply the moisture is affected by the temperature of the soil, the movement of water in the latter and the presence or absence of salts in solution. In this soil the temperature rises rapidly as soon as the air in the greenhouse becomes warm, and the roots in consequence immediately begin the work of supplying the leaves with water. The movement of the water in the soil is also rapid, so that the plant is able to utilize it rapidly.

While I have never seen the disease in the lettuce houses about Boston, the growers seem to be acquainted with it; and it is no doubt the superior skill which they possess that enables them to be free from it. One grower informed me that he always saturated his house with moisture in bright, sunshiny days which were preceded by cloudy weather, and by this means was able to prevent it.

REPORT OF THE ENTOMOLOGIST.

CHARLES H. FERNALD.

In the early part of 1896 the gypsy moth report mentioned last year was published by the State. This work consists of a bound volume of 608 pages, with 3 colored and 63 uncolored plates, and with 5 maps and 37 cuts in the text. The first part, comprising 263 pages, was prepared by the field director, and the second part, 244 pages, by myself, while the Appendix of 100 pages contains the reports of visiting entomologists and other papers. This work represents all that we were able to learn, up to the time of publication, of the history and habits of the notorious gypsy moth, its ravages in foreign countries as well as in our own, the means used for fighting it in other lands and also its natural enemies. Our experiments with methods for the destruction of this insect are still in progress, and occupy a large amount of time in study and work.

Quite extended studies have been carried on during the year on the spruce gall-louse (*Chermes abietis* Linn.), mainly by my assistant, Mr. R. A. Cooley, who with great care and perseverance has worked out the life history of this insect, which causes peculiar cone-like galls to form on the twigs of different varieties of spruce, rendering them unsightly and often nearly destroying them. The results of these studies are published in the thirty-fourth annual report of the college, with two plates showing the work and different stages in the life of this insect. Mr. Cooley was fortunate enough in his experiments to discover a good practical remedy for this insect, which consists in spraying the trees with a strong solution of whale-oil soap at the time these insects are in the most exposed state, which occurs during the winter or in the early spring, and also to cut off and burn the new galls in June before the insects

leave them. About five hundred circular letters were sent to all parts of the country last spring, and from the replies to these it appears that this insect already has a wide distribution in this country, and it is quite probable that in time it may become distributed wherever spruces grow.

Considerable time has been devoted to the study of cranberry insects during the summer, three trips having been made to the bogs on Cape Cod at the most favorable time for the study of these insects. There are, however, so many different species attacking the vines, and their mode of attack is so different one from another, that to learn their habits and the most effectual and economical method of destroying them forms a problem of no easy solution. We are therefore not yet ready to publish a final bulletin on these insects.

The army-worm has been unusually abundant the past year in many parts of the State, and numberless calls have been made on this department for information concerning the insect; in fact, the correspondence about the army worm during the summer was far greater than that of all other insects combined. Fortunately, we had already published a bulletin on this insect, and Mr. Kirkland, my assistant on the gypsy moth work in Malden, published an article on the army-worm in the "Crop Report" for September, 1896. It is not possible to foretell whether this insect will occur in injurious numbers next summer; but such a case would be quite unusual, as it has very rarely if ever in the past been abundant in the same locality two years or more in succession.

The elm-leaf beetle has not been so abundant in this State during the past summer as it was the year before, and this is true, as I learn, in other States. What the real cause of this decrease in numbers may be, I do not know. It may be due to a rapid increase of its vegetable parasites favored by a wet season. This, however, is all conjecture, as I have no positive evidence in the case.

The San José scale has occupied much attention; and, at the request of the president of the Shady Hill nurseries, I sent an assistant to make a critical examination of their stock at Bedford, Mass., and he reported to me that he discovered a large amount of infested stock in that nursery, which the

president promised to have burned. An examination made late this fall reveals the fact that the scale has not been entirely cleared from it. How widely this scale may be distributed in this State I am not able to say.

On the 12th of May I received a letter from L. C. Holt, Esq., of Ashby, Mass., and also a box of caterpillars which he stated were in immense quantities on the blueberry bushes, entirely stripping them of their leaves, and that unless something were done at once there would be no blueberry crop, and this would be a great misfortune, as many poor people derived quite a revenue from the berries picked from these bushes. The caterpillars proved to be the currant span worm (*Diastictis ribearia* Fitch); but the great difficulty which now presented itself was to offer some remedy which would not be as expensive as the value of the crop. I could think of no better or cheaper mode of destroying these span worms than to spray the bushes with Paris green in water, in the proportion of one pound of the former to one hundred and fifty gallons of the latter, and advised this course, if the crop was of sufficient importance to warrant the expense. This is the first time I have ever heard of this insect attacking the blueberry.

On the 17th of November I received a letter enclosing some twigs with scale insects on them from Mr. James Draper, who wrote me that they were taken from a golden-oak tree in one of the gardens of the city of Worcester, Mass. The scales proved to be what is known by the name of *Planchonia quercicola*, a European scale insect which has been in this country for some time. The first account of it here, so far as I know, was given in the report of the Department of Agriculture for 1880, page 330, where it is stated that it was found upon the imported oaks in the Department of Agriculture grounds at Washington. The insect has been found in New Jersey and also in New York, as I am informed by Professor Howard. It is regarded as a very injurious scale, and every effort should be made to destroy it by cutting off and burning the infested twigs, and thoroughly spraying the trees with whale-oil soap dissolved in water.

REPORT OF THE CHEMIST.

DEPARTMENT OF FOODS AND FEEDING.

J. B. Lindsey.
Assistants, E. B. Holland, G. A. Billings,* B. K. Jones.

Part I.

Laboratory Work.

Outline of year's work, together with chemical investigations of a technical character.

Part II.

Feeding Experiments and Dairy Studies.

(*a*) Effect of narrow and wide rations upon the quantity and cost of milk and butter, and upon the composition of milk.
(*b*) Rice meal *v.* corn meal for pigs.
(*c*) Oat feed *v.* corn meal for pigs.
(*d*) Digestion experiments with sheep.

Part III.

Compilation of fodder analyses.
Compilation of fertilizer constituents of fodders.
Compilation of analyses of dairy products.
Compilation of digestion coefficients.

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* Left Sept. 1, 1896.

Part I.

We have continued to analyze, free of cost, all feed stuffs, dairy products and waters sent to the station during the year. Results have been reported as promptly as possible, together with such comments as were considered necessary. There have been tested 63 samples of feed stuffs, 89 samples of whole milk, 11 samples of skim-milk, 9 samples of cream and 6 samples of butter; also 31 samples of milk and 20 samples of butter for the Dairy Bureau. These results are tabulated at the end of this report.

There have also been examined 134 samples of water, of which 10, or 7.5 per cent., were pronounced excellent; 50, or 37.5 per cent., fair; 39, or 29.1 per cent., suspicious; and 35, or 26.1 per cent., dangerous for drinking purposes.

In addition to the analyses above mentioned, which may be regarded as control work, we have made a very large number of analyses of feed stuffs, manures and milks, in connection with various animal experiments.

We have also spent considerable time in attempting to estimate some of the various substances composing the non-nitrogenous extract matter, and have compared different methods for the determination of starch in different feed stuffs, with a view of selecting one that will most correctly ascertain the true starch, when in combination with other substances of a similar nature. The results of some of the work are very briefly presented under the following heads: * —

1. *Remarks relative to the carbohydrates of agricultural plants and seeds.*
2. *Distribution of galactan.*
3. *The phloroglucin method for the estimation of pentosans.*

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* The work reported under these headings is of a technical character.

SOME REMARKS RELATIVE TO THE CARBOHYDRATES OF AGRICULTURAL PLANTS AND SEEDS.

J. B. LINDSEY.

Agricultural chemists have divided the dry matter of plants into five groups of substances, namely, crude ash, crude fibre, crude fat or ether extract, and non-nitrogenous extract matter. These terms, as is well known, do not stand for single ingredients, but rather for groups of substances having similar characteristics. The terms crude fibre and extract matter are spoken of collectively as carbohydrates. Our knowledge of the individual substances composing the fibre and extract matter has until recently been rather vague. The investigations of Tollens, Schulze and their pupils have, however, thrown considerable light, and revealed the presence and characteristics of many of the substances entering into their composition. The crude fibre of agricultural plants, as prepared by the method employed by Henneberg and Stohmann, is now known to consist principally of dextroso-cellulose (a hexa-cellulose), combined with more or less lignin or lignin acids. The fibre has also been found to contain considerable pentosan, so intimately associated with the hexa-cellulose as to be considered a penta-cellulose. Whether the penta-cellulose is actually united with the lignin as a ligno-cellulose is uncertain. The true celluloses are characterized principally by their nearly complete insolubility in dilute mineral acids and in F. Schulzes' reagent, and by their solubility in copper ammonium oxide. When cellulose is dissolved in quite concentrated sulphuric acid, and the resulting product hydrolized with dilute acid, Schulze has as a rule obtained dextrose; hence the name dextroso-cellulose. Schulze found that the cellulose obtained from wheat bran, peas and lupine seeds yielded only dextrose; that obtained from rye straw, lupine pods, spruce wood and

red clover, gave dextrose and xylose; while that prepared from the coffee bean, cocoanut and sesame cake, yielded dextrose and mannose. There exist, therefore, dextroso-, mannoso- and pentoso- celluloses. That the so-called crude fibre is not pure cellulose, but in addition to both hexa- and penta- cellulose contains more or less lignin, is probable from the fact that it is colored a bright red by phloroglucin and hydrochloric acid, and because it contains a higher percentage of carbon than pure cellulose. When the dried and finely ground plant or seed is treated according to the Weender method, a considerable portion of the lignin is split off, and reckoned as extract matter.

The term non-nitrogenous extract matter is meant to include all substances, not included within the other four groups, that are removed by means of dilute acid and alkali. In case of the grains, the extract matter is known to consist largely of starch; but when derived from coarse fodders, leguminous seeds and many by-products, its composition has been, until the investigations of Tollens and Schulze, but little understood.

To these carbohydrates that can be removed from the plant by the action of dilute mineral acid and alkali, and that are as a rule soluble in F. Schulze's reagent, E. Schulze has applied the name *hemi-cellulose.* Under this head he would bring the mother substances, dextran, levulan, mannan, galactan, araban and xylan, which yield, on inversion, the sugars dextrose, levulose, mannose, galactose, arabinose and xylose. It is the mother substances of these sugars and probably others of a similar nature not yet identified, together with ready-formed sugars, starch, and a portion of the lignin, as above alluded to, which constitute the extract matter. These hemi-celluloses are intermixed with the true celluloses and ligno-celluloses in the cell walls of plants and seeds. In some cases they have been recognized as reserve material, and are used as food in the sprouting of the seed. The levulan and mannan do not appear to be generally distributed. The araban and xylan (pentosans), on the other hand, constitute fully one-third of the extract matter of all hays and straws; they are quite prominent in the hull and bran of different grains and seeds, and are even found in the endosperm and cotyledons of many seeds.

THE DISTRIBUTION OF GALACTAN.

J. B. LINDSEY and E. B. HOLLAND.

Galactan, one of the hemi-celluloses, was first extracted from lucerne seeds by Müntz,* and was converted into galactose by boiling with dilute acid. E. Schulze † and his co-workers found galactan quite prominent in the seeds of the blue lupine. The finely ground seeds were extracted with ether, alcohol, one per cent. soda solution at a low temperature to remove albuminoids, washed with water, and the residue boiled with dilute sulphuric acid. The solution was afterwards neutralized with barium carbonate, filtered, and evaporated to a syrup. This syrup was extracted with hot alcohol, and the alcoholic solution on slow evaporation yielded sugar crystals which proved to be galactose. The mother substance, yielding galactose, was also found to contain a pentose (probably arabinose). Schulze, therefore, called the substance para-galactoaraban. An examination of the pea, soy and field bean, showed the presence of the same substance. The coffee bean, date seed, palm and cocoanut cake proved the presence of galactan and mannan in liberal quantities, indicating the presence of a substance which might be termed galactomannan. Whether these substances are chemically united into complex molecules, or whether they are simple mixtures, it is hardly possible to state.

As a result of this work, Schulze assumed that the hemi-cellulose galactan might be very generally distributed in agricultural plants; and, if such should be the case, it must be of importance as a source of nutrition.

* Bull. Soc. Chim. (2) 37, p. 409.

† Zeitsch für physiol. chem. Bd 14. Heft 3; Zeitsch für physiol. chem. Bd 16, Hefts 4 and 5.

Recognizing the comparatively few fodder plants and seeds that had been tested for galactan, we thought it would prove interesting to make a quantitative estimation of the amount of the substance present in all the more important feed stuffs. While the method employed by Schulze, namely, the inverting of the galactan with dilute mineral acid and allowing the resulting sugar to crystallize out, is of course a sure proof of the presence of galactose, if properly identified, it does not admit of a *quantitative estimation* of the sugar. We therefore had recourse to the indirect method of estimating the mucic acid, as a measure of the quantity of galactose present. Scheele * was the first to recognize that by the oxidation of milk sugar, mucic acid resulted. Pasteur † found that it was the galactose of the milk sugar that yielded mucic acid. Tollens and Kent, ‡ after numerous experiments, proposed the following method for obtaining the largest amount of mucic acid both from milk sugar and from galactose. They evaporated 100 grammes of milk sugar with 1,200 c.c. of nitric acid of 1.15 specific gravity in a water bath to one-third of its volume, allowed the solution to stand twenty-four hours for the mucic acid to crystallize out, then filtered onto a tared filter and dried and weighed it. This method yielded 37 to 40 per cent. of mucic acid. When pure galactose was used, a double quantity — 74–77 per cent. — was obtained. § Rischbieth, Creydt, Hadecke and Tollens still further perfected the method, and used it in ascertaining the galactan in a variety of substances. This perfected method we have used with but slight modifications in the estimation of galactan in the substances which follow.

Method. — Three grammes of the substance were brought into a beaker about 5.5 c.m. in diameter and 7 c.m. deep, together with 60 c.c. of nitric acid of 1.15 specific gravity, and the solution evaporated to exactly one-third of its volume in a water bath at a temperature of 94 to 96 degrees C. After standing twenty-four hours, 10 c.c. of water are added to the precipitate, and it is allowed to stand another twenty-four

* Opuscula chemica et physica, Leipsig, 1789, p. 111.

† Comp. rend. 42, p. 347.

‡ Ann. Chem. 227, p. 221.

§ Landw. Versuchs-Stationen 39, p. 401.

hours. The mucic acid has in the mean time crystallized out, but is mixed with considerable material only partially oxidized by the nitric acid. The solution is therefore filtered through filter paper, washed with 30 c.c. of water, to remove as much of the nitric acid as possible, and the filter and contents brought back into the beaker. Thirty c.c. of ammonium carbonate solution * are now added, and the beaker brought into a water bath and heated gently for fifteen minutes. The ammonium carbonate takes up the mucic acid, forming the soluble muciate of ammonia. The solution is now filtered into a platinum or porcelain dish, and the residue thoroughly washed with water to remove all of the muciate of ammonia. The filtrate is then evaporated to dryness over a water bath, and 5 c.c. of nitric acid of 1.15 specific gravity are added, thoroughly stirred and allowed to stand for thirty minutes. The nitric acid decomposes the ammonium muciate, precipitating the mucic acid, which is now filtered onto a tared filter, or into a Gooch crucible, washed with 10 to 15 c.c. of water, with 60 c.c. of alcohol and quite a number of times with ether, dried at 100° C. for a short time, and weighed. The mucic acid multiplied by 1.33 gives galactose, and this multiplied by .9 gives galactan.

The method gives fairly good results, but, like other methods that are employed in estimating substances formed by physiological processes, absolute accuracy is hardly to be expected. For example, when extracting the mucic acid from the impurities with ammonium carbonate, more or less of the partially decomposed organic matter is dissolved out, which is again precipitated by the addition of the nitric acid. After the mucic acid is filtered and washed with alcohol and ether, a considerable portion of this material is dissolved out; some, however, still remains, and gives the otherwise white mucic acid a grayish color. It is possible that such a condition might be obviated by previously treating the *substance to be examined* with alcohol, ether and one per cent. soda solution in the cold, in order to remove fat, coloring matter and protein substances. Whether this could be done without loss of any of the substance is a question for further study.

* One par ammonium carbonate, 19 parts water and 1 part strong ammonia.

Results.

Coarse Fodder.

	Galactose.	Galactan.
	Per Cent.	Per Cent.
English hay,	1.01	.91
High-grown salt hay,	.93	.84
Black grass,	.71	.64
Corn stover,	.76	.68
Oat straw,	.81	.73
Rye straw,	.63	.57
Fodder millet,	.95	.86
Canada beauty pea fodder,	3.09	2.78
Medium red clover fodder,	3.73	3.36
Alsike clover fodder,	4.25	3.83
Mammoth clover fodder,	3.77	3.39

Concentrated Feeds.

Corn meal,	.05	.05
Wheat meal,	.23	.21
Oat meal,	.81	.73
Barley meal,	.55	.50
Wheat bran,	.43	.39
Millet meal,	.67	.60
Linseed meal,	1.31	1.15
Cotton-seed meal,	.63	.57
Rice meal,	1.04	.96
Rape seed,	1.07	.96
Brewers' grain,	.56	.50
Malt sprouts,	.43	.39
Dwarf horticultural bean,	.68	.61
Green soy bean,	.67	.60
Black soy bean,	.92	.83
Bush lima bean,	.79	.71
Pole lima bean,	.66	.59
Black wax bean (dwarf),	.52	.47
White pot bean,	.53	.48
Horse bean,	1.83	1.65
Canada beauty pea,	.63	.57
Prussian blue pea,	.75	.68
English gray pea,	.84	.76
Little gem pea,	1.16	1.04
Wonder pea,	1.62	1.46
Pea meal,	2.69	2.42
Vetch seed,	1.17	1.05
Serradella seed,	.66	.59
Medium red clover seed,	2.77	2.49
Mammoth clover seed,	3.63	3.27
Crimson clover seed,	3.49	3.14
Alsike clover seed,	8.96	8.06
Sweet clover seed,	6.00	5.40
White clover seed,	10.08	9.07
Alfalfa seed,	5.23	4.71
White lupine seed,	13.84	12.46
Blue lupine seed,	16.29	14.66

Many of the substances tested show less than one per cent. of galactan, and we are not certain in many cases, because of the small amount of precipitate obtained, whether the material weighed really was mucic acid or partially decomposed organic matter. All substances, therefore, containing less than one per cent. of galactan, may be for the present characterized as doubtful. To settle the presence or absence of very small amounts of galactan, we shall either be obliged to still further perfect the method, or work with larger quantities. Tollens states that mucic acid melts at 213 degrees C. We have tested the melting point of the precipitate in cases when there was sufficient present, and found a melting point of about 215 degrees C.

The results as given above show the presence of very small amounts of galactan in the non-leguminous coarse fodders and seeds. In the leguminous plants from three to four per cent. are present, while in case of the leguminous seeds, several varieties of beans and peas appear to contain very limited quantities, but the larger number of such seeds tested show from 1½ to as high as 14 per cent. With the exception of the lupines, the clover seeds contain the largest amounts, the seeds of white variety containing 9 per cent.

The above results are merely a report of progress. They show, however, that the galactans are not as widely distributed nor present in such large quantities as are the pentosans, and therefore do not play such an important part as do the latter in the process of nutrition. We propose to continue the investigation of the distribution of these substances, and also to determine their digestibility.

THE PHLOROGLUCIN METHOD FOR THE ESTIMATION OF PENTOSANS.

J. B. LINDSEY and E. B. HOLLAND.

Councler * has suggested that, instead of phenylhydrazin, phloroglucin be employed for the precipitation and estimation of furfurol obtained by the distillation of various substances, with dilute hydrochloric acid. Kruger and Tollens † have further studied and perfected the method, and recommended it as reliable for the estimation of pentosans in various coarse fodders, grains and vegetables.

The phloroglucin, like the phenylhydrazin method, is based on the fact that the pentosans (araban, xylan, etc.) differ from other carbohydrates in that they yield furfurol instead of levulinic acid upon digestion with moderately dilute hydrochloric or sulphuric acids. The first step necessary in both processes for a quantitative estimation is the conversion of the pentosans into furfurol and its separation from the resulting by-products.

Phloroglucin Method described.

Three grammes of the material are brought into a ten-ounce flask, together with 100 c.c. of 12 per cent. hydrochloric acid (specific gravity, 1.06), and several pieces of recently heated pumice stone. The flask, placed upon wire gauze, is connected with a Liebig condenser, and heat applied, rather gently at first, and so regulated as to distil over 30 c.c. in ten to fifteen minutes from the time that boiling begins. The 30 c.c. driven over are replaced by a like quantity of the dilute acid, by means of a separatory funnel; and the process so continued as long as the distillate gives a pronounced reaction with aniline acetate on filter paper (a

* Chemikerztg, 1894, No. 51. † Zeitsch. für Ang. Chem., 1896, Heft II.

few drops of aniline in a little 50 per cent. acetic acid). To the completed distillate is gradually added a quantity of phloroglucin * dissolved in 12 per cent. hydrochloric acid, and the resulting mixture thoroughly stirred. The solution first turns yellow, then green; and very soon an amorphous greenish precipitate appears, which grows rapidly darker, till it finally becomes almost black. The solution is made up to 500 c.c. with 12 per cent. hydrochloric acid, and allowed to stand over night. In case there is very little furfurol in the substance tested, and the resulting distillate consequently small, it is best to add sufficient 12 per cent. hydrochloric acid to the distillate before adding the phloroglucin solution, so that, upon the addition of the latter solution, the resulting mixture will contain approximately 500 c.c.

The amorphous black precipitate is filtered into a tared Gooch crucible through an asbestos felt, washed with 100 c.c. of water, dried to constant weight by heating three to four hours at 100 degrees C., cooled and weighed, the increase in weight being reckoned as phloroglucid. To calculate the furfurol from the phloroglucid,† use the following table: —

TOTAL WEIGHT OF PHLOROGLUCID OBTAINED.	Divided by, equals Furfurol.	TOTAL WEIGHT OF PHLOROGLUCID OBTAINED.	Divided by, equals Furfurol.
.20 gramme, . .	1.820	.34 gramme, . .	1.911
.22 " . .	1.839	.36 " . .	1.916
.24 " . .	1.856	.38 " . .	1.919
.26 " . .	1.871	.40 " . .	1.920
.28 " . .	1.884	.45 " . .	1.927
.30 " . .	1.895	.50+ " . .	1.930
.32 " . .	1.904		

Furfurol ÷ by grammes substance taken × 1.84 = pentosans.
Furfurol ÷ by grammes substance taken × 1.65 = xylan.
Furfurol ÷ by grammes substance taken × 2.03 = araban.

* Dissolve twice as much dry phloroglucin as furfurol expected in about 50 c.c. of 12 per cent. hydrochloric acid. Bring the hydrochloric acid into a water bath, and stir thoroughly till the phloroglucin goes into solution.

† The phloroglucid is a complex substance, of uncertain formula. It contains 63 to 64 per cent. of carbon and from 3.6 to 4.2 per cent. of hydrogen. The factors for calculating the amount of furfurol from the phloroglucid were obtained after experimenting with known amounts of pure furfurol and phloroglucin.

The amount of pentosans was estimated by both the phenylhydrazin and the phloroglucin methods in the following substances: —

	Phenylhydrazin Method (Per Cent.).	Phloroglucin Method (Per Cent.).
English hay,	21.28	22.50
High-grown salt hay,	25.64	25.74
Branch grass,	24.65	26.43
Low meadow fox grass,	27.98	27.91
Buffalo gluten feed,	16.45	16.00
Lupine seeds,	9.42	9.64

With two exceptions the two methods show very closely agreeing results. We propose to still further compare these methods in the near future. The phloroglucin method, on account of its greater simplicity, is much to be preferred.

Part II.

(*a*) THE EFFECT OF NARROW AND WIDE RATIONS ON THE QUANTITY AND COST OF MILK AND BUTTER, AND ON THE COMPOSITION OF MILK.

J. B. LINDSEY, E. B. HOLLAND and GEO. A. BILLINGS.

Results of Two Experiments.

I. Definition: By narrow ration is meant one containing 4 to 5 times as much carbohydrates as protein (1 : 5); by wide ration one containing 8 to 10 times as much carbohydrates as protein (1 : 10).

II. The same amount of digestible matter in narrow rations produced from 11.8 to 12.9 per cent. more milk than did a like amount of digestible matter in wide rations; narrow rations also reduced the cost of production from 5 to 12 per cent.

III. The average cost of a quart of milk produced with the narrow rations was 1.81 cents, and with the wide rations 1.97 cents.

IV. The narrow rations produced over the wide rations practically the same relative increase in the amount of butter and the same decrease in the cost of production as in the case of the milk.

V. The narrow rations produced butter at a cost of 15.57 cents per pound, and the wide rations at a cost of 16.52 cents per pound.

VI. In Experiment I., with the narrow rations, the best cow produced 12.2 pounds of butter in a week, at a cost of 14 cents per pound; and the poorest cow produced 8.26 pounds, at a cost of 19.37 cents per pound. In the same experiment, with the wide ration, the best cow produced 9.52 pounds, at a cost of 16.67 cents per pound; and the poorest cow produced 7.28 pounds, at a cost of 18.88 cents per pound.

In Experiment II., on the narrow ration, the best cow produced 12.81 pounds of butter per week, at a cost for feed consumed of 11.66 cents; and the poorest cow 7.98 pounds, at a cost of 15.90 cents per pound. With the wide ration, the best cow produced 10.92 pounds per week, costing 12.71 cents; and the poorest cow 6.86 pounds, costing 16.21 cents per pound.

VII. In these two experiments narrow rations produced manure having 20 per cent. more fertilizing value than that produced by wide rations. In general, it can be said that narrow rations produce manure containing 10 to 15 per cent. more fertility than wide rations.

VIII. Neither the narrow nor wide ration produced any decided change in the composition of the milk.

IX. For total consumption of dry and digestible matter; total yields of milk, milk solids and fat; pounds of milk, milk solids and fat produced by 100 pounds of dry and digestible matter; and for digestible matter required to produce 100 pounds of milk, 1 pound of milk solids and 1 pound of butter,— see tables XII., XIII. and XIV., in rear of this report.

A. Methods employed in carrying out the Experiments.

Plan.

The experiments were two in number, and were conducted during the autumn and winter of 1895–96, with six cows. The animals were divided as evenly as possible into two lots, and the experiments were so arranged that in the first half of each experiment three of the cows were fed the narrow rations while the other three were receiving the wide rations; in the second half of the experiment the order was reversed. In this way the natural milk shrinkage as well as the natural change in the quality of the milk was equalized. In the first experiment the two halves each lasted twenty-six days, and at least seven days were allowed after the animals were placed upon the full ration before the actual test began. In Experiment II. the halves each lasted twenty-one days.

History of Cows.

NAME.	Breed.	Age.	Last Calf dropped.	Milk Yield at Beginning of Experiments.	
				I.	II.
		Years.		Pounds.	Pounds.
I. Ada, . . .	Grade Ayrshire, .	7	Oct. 1,	26	22
II. Una,* . . .	Native, . . .	10	Sept. 1,	22	-
II. Guernsey,† . .	Grade Guernsey, .	7	Dec. 1,	-	30
III. Bessie, . . .	Grade Ayrshire, .	7	Sept. 10,	27	26
IV. Beauty, . . .	Grade Jersey, . .	5	Sept. 15,	27	20
V. Red, . . .	Grade Durham, . .	7	Oct. 8,	33	27
VI. Spot, . . .	Grade Durham, . .	7	Oct. 8,	34	27

* Used in first experiment. † Used in second experiment.

The animals had been purchased in the neighborhood, at an average cost of $50 each, when fresh. They were better animals than the average, and most of them had been dry for several months before calving, so that they would naturally be able to do their best work during the two experiments now being described. None of the animals had been served at the beginning of the experiment, but they were allowed to take bull later. Most of them were served between the two halves of the first experiment.

Feeds and Feeding.

In the first experiment all of the cows were fed hay and sugar beets as coarse feeds. In the wide ration half, each cow had one pound more of hay daily than in the narrow ration half, in order to make up a like amount of total digestible daily nutrients. Chicago gluten meal and wheat bran were fed in the narrow ration, and corn meal and wheat bran in the wide ration. The hay was quite coarse, and consisted of Timothy, with an admixture of clover. Cow II. left a small quantity of the coarser portion in one half, which was deducted from the amount consumed in calculating the digestible daily nutrients eaten.

In the second experiment the coarse feeds consisted of hay, and millet and soy bean ensilage; the concentrated feeds in case of the narrow ration were bran, Chicago gluten

meal and old-process linseed meal; and in case of the wide ration, wheat bran and corn meal. In this experiment the feeds were entirely consumed.

The feeds were very carefully weighed out, and given twice daily. Water was kept before the animals constantly, by means of the Buckley self-watering device. A cover swung upon hinges kept the feed from getting into the water. The animals very soon learned to lift the cover whenever they desired to drink.

Sampling the Feeds.

A small sample of the different grain feeds was taken daily, and preserved in glass-stoppered bottles; a sample of the hay was taken weekly, and likewise preserved; and at the end of each of the two halves of each experiment dry-matter determinations were made and samples preserved for analysis. In case of the sugar beets and ensilage, samples were taken weekly and tested for dry matter at once, and at the close of the experiment these several samples were mixed and preserved for analysis.

General Care.

The cows were milked twice daily, about five o'clock in the morning and five in the afternoon, always by the same attendant, who was a graduate of the college, and thoroughly trustworthy. The animals were carded daily, and allowed the run of a yard in pleasant weather. They were given plenty of stall room, and made as comfortable as possible. The wing of the stable in which they were confined contained no storage room, and each animal was allowed fully 1,200 cubic feet of air. The wing was heated with hot water, and kept at a temperature of 50 to 55 degrees F. during the winter months. Ventilation was secured by means of a shaft 8 by 15 inches, placed at the south end of the wing, running to within 1 foot of the floor, and extending 12 feet above the roof, terminating in a so-called Archimedean ventilator. In the shaft was placed a hot-water coil, to increase the draught. Air was admitted by means of windows opening into the barn, thus avoiding direct draughts. The windows were sufficient in number to keep the barn fully lighted.

Weighing the Animals.

The animals were weighed before feeding in the afternoon at the beginning and end of the experiment, and once a week during its continuance. It is recognized that this was not sufficient, and in experiments now being made the animals are weighed for three successive days at the beginning and end of the experiment and the same number of times weekly during its continuance.

Care of the Milk.

The milk was weighed at once after being drawn, on a Chatillon balance sensitive to two ounces. Composite samples were taken for five days of each week, the milk being preserved with the aid of bichromate of potash. In order to secure an average sample, it was poured from one pail to another three times, and then 10 c.c. removed with the aid of a pipette, an exact amount being taken at every milking. The glass jars containing the composite samples were kept tightly covered, and were gently rotated each day, to prevent any undue clotting of the cream.

Testing the Milk.

The tests were in all cases made in duplicate. The total solids were made either by the sand method or by use of the perforated disk filled with asbestos. The fat was determined by the gravimetric method, and in case of Experiment II. total nitrogen was estimated by the Kjeldahl method.

Experiment I.

DATES OF EXPERIMENT.	Narrow Ration.	Wide Ration.
October 24 through November 18, ...	Cows I., IV., VI.	Cows II., III., V.
November 28 through December 23, . . .	Cows II., III., V.	Cows I., IV., VI.

Experiment II.

January 27 through February 16, ...	Cows I., II., VI.	Cows III., IV., V.
February 29 through March 20, ...	Cows III., IV., V.	Cows I., II., VI.

B. Rations consumed, and Their Effect on the Quantity and Cost of Milk and Butter.

Average Daily Rations fed to Six Cows (Pounds).

Experiment I.

Character of Ration.	Wheat Bran.	Chicago Gluten.	Linseed Meal.	Corn Meal.	Hay.	Sugar Beets.	Millet and Bean Ensilage.
Narrow ration,	3	5.83	-	-	15.17	12	-
Wide ration,	3	-	-	5.83	16.17	12	-

Experiment II.

Character of Ration.	Wheat Bran.	Chicago Gluten.	Linseed Meal.	Corn Meal.	Hay.	Sugar Beets.	Millet and Bean Ensilage.
Narrow ration,	2.83	3 00	1.92	-	10.33	-	28.33
Wide ration,	1.92	-	-	5.83	10.33	-	28.33

Average Weight of Animals and Total Digestible Nutrients in Daily Rations (Pounds).

Experiment I.

Character of Ration.	Weight of Animal.	Protein.	Fat.	Carbohydrates.	Total.	Nutritive Ratio.
Narrow ration,	941	3.07	.59	10.23	14.06	1:3.86
Wide ration,	938	1.46	.52	12.45	14.43	1:9.43

Experiment II.

Character of Ration.	Weight of Animal.	Protein.	Fat.	Carbohydrates.	Total.	Nutritive Ratio.
Narrow ration,	899	2.85	.65	9.96	13.46	1:4.04
Wide ration,	890	1.45	.54	11.44	13.42	1:8.85

The difference between the two rations in Experiment I. consists in the fact that gluten meal high in protein was substituted for corn meal low in protein. In Experiment II.

gluten and linseed meals were substituted for corn meal. It might have been better had the coarse feeds been increased somewhat, in order to have raised the total digestible nutrients to 15 pounds daily. The animals, however, maintained very even average weights during both experiments. In both halves of each experiment the total digestible nutrients were practically the same.

TABLE I. — *Yield and Cost of Milk.*

Experiment I. 26 Days (6 Cows).

CHARACTER OF RATION.	Total Yield (Pounds).	AVERAGE DAILY YIELD.		Total Cost of Feed consumed.	Cost of Feed to produce a Quart of Milk (Cents).	Cost of Feed to produce 100 Pounds of Milk (Cents).
		Quarts.	Pounds.			
Narrow, ...	4241.5	12.65	27.2	$36.84	1.89	87.0
Wide, ...	3695.5	11.03	23.7	35.34	2.11	95.7
Increase narrow over wide ration, .	546.0	1.62	3.5	1.50	—.22	—8.7
Percentage increase, ...	12.9	-	-	-	—11.70	-

Experiment II. 21 Days (6 Cows).

CHARACTER OF RATION.	Total Yield (Pounds).	Quarts.	Pounds.	Total Cost of Feed consumed.	Cost of Feed to produce a Quart of Milk (Cents).	Cost of Feed to produce 100 Pounds of Milk (Cents).
Narrow, ...	3261.0	12.01	25.82	$26.27	1.74	80.6
Wide, ...	2877.0	10.58	22.73	24.43	1.83	84.9
Increase narrow over wide ration, .	384.0	1.43	3.03	1.84	—.09	-
Percentage increase, ...	11.8	-	-	-	—5.20	-

The above table shows that the narrow rations produced from 11.8 to 12.9 per cent. more milk than did the wide rations, and that they reduced the cost of production from 5 to 12 per cent. At the end of Experiment II., six months after calving, the cows were averaging between 11 and 12 quarts of milk daily.* It was not the primary object of these two experiments to select the most economical feeds for milk production, but rather to note the effect of narrow *v.* wide rations on the *quality* of the milk. The figures, however, cannot fail to prove interesting to the milk producer.

* Cow No. 2, at the close of Experiment II., had been calved but three months.

TABLE II. — *Yield and Cost of Butter.*

Experiment I. 26 Days (6 Cows).

CHARACTER OF RATION.	Total Yield of Butter Fat.	Equivalent to Butter.	Average Daily Yield.	Average Weekly Yield.	Average Cost of Feed per Pound of Butter produced.
	Pounds.	Pounds.	Pounds.	Pounds.	Cents.
Narrow, ...	190.90	222.71	8.55	59.85	16.74
Wide, ...	164.87*	192.01	7.11	49.77	18.41
Increase narrow over wide ration,	26.03	30.70	1.44	10.08	—1.67
Percentage increase, . . .	13.70	13.70	-	-	—10.00

Experiment II. 21 Days (6 Cows).

Narrow, ...	157.69	183.98	8.75	61.25	14.40
Wide, ...	144.56	168.64	8.01	56.07	14.64
Increase narrow over wide ration,	13.13	15.34	.74	5.18	—.24
Percentage increase, . . .	8.30	8.30	-	-	—1.67

The figures tell the same story as they did in the yield of milk. On the narrow rations the cows produced 13.7 per cent. more butter in Experiment I. and 8.3 per cent. more in Experiment II. than they did on the wide rations. In Experiment I. the cost of feed per pound of butter produced was 16.74 cents for the narrow ration and 18.41 cents for the wide ration, showing that the narrow ration produced butter for 10 per cent. less per pound than did the wide ration. In Experiment II. the cost of feed per pound of butter produced was 14.57 cents for the narrow and 14.64 cents for the wide ration, showing a difference of but 1.67 per cent. in favor of the narrow ration.

It is of course impossible to state with accuracy the exact cost of feed required to produce a pound of butter, as so

* Cow V. (Red) during a portion of this period produced milk with but 2.85 per cent. of fat, and then suddenly increased to 4 per cent. The above figures include this cow's production on the basis of 4.05 per cent. fat for the entire period; otherwise the percentage increase of the butter in the narrow ration would be more than the percentage increase in the milk produced, which might lead to the supposition that the narrow ration had actually increased the percentage of fat in the milk, when really this sudden increase of fat was entirely independent of the influence of the feed.

much depends upon the cost of feeds used, character of the cows, and the stage of lactation. The figures simply show what six of the better class of ordinary cows that had been well fed were able to do, during the first six months after calving.

TABLE III. — *Yield and Cost of Butter from Poorest and Best Cows.*

CHARACTER OF COW AND RATION.	Experiment I.			Experiment II.		
	Daily Yield.	Weekly Yield.	Cost of Feed per Pound.	Daily Yield.	Weekly Yield.	Cost of Feed per Pound.
	Pounds.	Pounds.	Cents.	Pounds.	Pounds.	Cents.
Best cow, narrow, . .	1.74	12.20	14.00	1.83	12.81	11.66
Poorest cow, narrow, .	1.18	8.26	19.37	1.14	7.98	15.90
Best cow, wide, . . .	1.36	9.52	16.67	1.56	10.92	12.71
Poorest cow, wide, . .	1.04	7.28	18.88	.98	6.86	16.21

In Experiment I. the best cow on the narrow ration produced 12.2 pounds of butter per week, at a cost for feed consumed of 14 cents per pound; while the poorest cow produced 8.26 pounds, at a cost of 19.37 cents per pound. In the same experiment on the wide ration one cow produced 9.52 pounds per week, costing 16.67 cents per pound; and another 7.28 pounds per week, costing 18.88 cents.

In Experiment II. the best yield with the narrow ration was 12.81 pounds of butter per week, costing for feed eaten 11.66 cents per pound; and the poorest yield was 7.98 pounds, costing 15.90 cents. In the same experiment on the wide ration the best yield was 10.92 pounds weekly, costing 12.71 cents per pound; and the least yield 6.86 pounds weekly, costing 16.21 cents per pound. One is enabled from the above figures to note both the influence of the cow and the cost of the daily ration upon the cost of the butter produced. The cow yielding 12.81 pounds weekly, at a cost of 11.66 cents per pound for food consumed, was a grade Guernsey, fresh at the time. Her general form and appearance would not indicate that she was more than a very ordinary cow. She produced about 14 quarts of milk daily when at her best, containing 5.3 per cent. of butter fat. Such facts as the above ought certainly to stimulate farmers to ascertain the amount and quality of the milk produced by

their cows during a period of lactation. Only by such a course can the unprofitable cows be weeded out, and the herd brought to a higher standard. The scales and the Babcock tester are necessary; mere guess will not accomplish it.

TABLE IV. — *Approximate Estimate of the Amount and Value of Fertilizer Constituents in Excretions of the 6 Cows.*

CHARACTER OF RATIONS.	Nitrogen (Pounds).	Phosphoric Acid (Pounds).	Potash (Pounds).	Relative Values of Same.
Average of Experiments I. and II., narrow, .	153	35	79	$28 65
Average of Experiments I. and II., wide, . .	108	40	95	22 95
Percentage increased value of narrow over wide ration, .				$19 20

For the sake of comparison, by figuring the value of the nitrogen, phosphoric acid and potash contained in the feeds consumed (less 20 per cent. for the amount retained in the system or otherwise lost) by the market cost of these several ingredients per pound, it will be seen that the manure from the narrow ration has 20 per cent. more value than that from the wide ration. The cause of the increased value lies naturally in the increased amount of nitrogen present. In case of the rations fed in these experiments, the fact that the wide ration has more potash than the narrow is because gluten meal, which served to increase the protein, contains but minimum amounts of this ingredient. If cotton or linseed meal had been used in place of the gluten meal, the reverse would have been true. While the so-called narrow rations as used in these experiments were extreme ones, it might be said that narrow rations which contain from 2 to 2½ pounds of digestible protein in a day's feed, aside from their causing a 10 per cent. increase in the milk yield, furnish in addition a manure from 10 to possibly 15 per cent. more valuable than do wide rations.

While narrow rations will unquestionably produce more milk and butter than wide rations, the relative cost of the milk and butter produced by the two rations will depend

upon the price of the concentrated feed stuffs. The markets, however, at the present time contain such a great variety of these products that the feeder can select those rich in protein at prices that will enable him to feed the narrow or so-called well-balanced rations to advantage.

In the closing remarks on this portion of the experiment, it is well to inquire what are to be considered as economical narrow rations. The German ration established so long ago by the late Emil von Wolff contained, for cows of 1,000 pounds weight, 2.5 pounds of digestible protein, .5 pounds of digestible fat and 13 pounds of digestible carbohydrates, with a proportion of protein to fat and carbohydrates of 1 to 5.4.

The writer is convinced that 2.5 pounds of digestible protein daily is amply sufficient, and seriously questions whether it is not too much. More than this amount, or even 2.5 pounds daily in the form of concentrated feed stuffs, if fed from eight to nine months each year, will soon tend to impair the milk-producing capacity of the cow. Some cows might be able to withstand such feeding longer than others. It might be advisable, for economic reasons, to feed as high as 3 pounds of digestible protein daily to average cows for two or three years, and then turn them into beef; but cows possessing more than ordinary merit should be differently handled. It should ever be kept in mind that it is far better to breed and select cows that possess extra milk and butter qualities than to attempt to attain those ends by extra amounts of concentrated feeds.

The amount of protein, as well as the amount of total digestible organic nutrients, that can be fed in the daily ration in order to produce milk and butter at low prices, and at the same time not impair the milk-producing organs by overwork, is still an uncertain quantity; and in order to secure more accurate information, taking into consideration American conditions, extended and carefully conducted investigations are necessary. Such experiments should be carried out only by those who can control all the conditions, who thoroughly understand the nature, handling and care of animals, and who have the time to give the experiments a close personal attention.

C. The Effect of Narrow and Wide Rations on the Quality of the Milk.

Many experiments have been published and many opinions expressed relative to the effects of single feeds and feed combinations on the quality of milk. The writer has briefly reviewed the most important of these experiments elsewhere.* W. H. Jordan † has recently also presented a most excellent review and critical examination of such experiments.

Practically all of the experiments thus far made have taught that feeds have but very little influence on the quality of milk. By "affecting the quality" is meant the increasing and decreasing of any or all of the solid constituents of the milk, such as casein, albumin, milk sugar, fat and ash. It is a commonly recognized fact that some feeds affect the flavor of milk, and to a slight extent its color, also possibly its acidity and alkalinity. It is possible that feeds and feed combinations rich in fat have a tendency to slightly increase the percentage of fat in the milk of some cows. Whether or not feeds rich in protein have a similar tendency, is still uncertain. It is probable that this increase is only of a temporary character, the milk gradually coming back to its normal condition. Animals very thin in flesh and insufficiently fed, if brought into good condition by proper feed, will probably show an increase in one or all of the solid constituents. This improvement will certainly not be very marked. It is possible that the improvement in the milk brought about by the more complete nourishment of a thin and insufficiently fed animal consists more in an improvement in the *quality* of the fat, or nitrogenous matter, than in increasing to any marked degree their actual percentages in the milk. The quality of milk varies, as is well known, during the different stages of lactation, but this is entirely independent of the influence of feed.

In conducting experiments of this character the investigator should be very careful that he is able to control all the conditions liable to in any way affect the results. The milk-

* Twelfth report of Massachusetts Experiment Station, 1894.

† Agriculture of Maine, 1895, page 139.

producing organs are largely under the control of the nervous system, and any sudden change disturbing the nervous temperament of the animal, such as a sudden extreme change of temperature, an angry man, change of milkers, etc., is very likely to have an effect on the quality of her product. This can easily be observed by testing the milk daily and noting the variations, especially in the percentage of fat. Too short periods render such experiments valueless, as well as changing the entire daily character of the feed in two or three parts of a single experiment. No greater mistake can be made than in employing cheap, unreliable help. The results of many of the experiments thus far made along this line of investigation are of absolutely no value, because one or several improper influences have not been controlled by the experimenter.

In the two experiments which follow, the experimenter has sought as far as possible to prevent any influence other than the one desired to have any bearing on the results. The methods have been described under A. The complete feeding record of each cow will be found at the end of this article.

TABLE V. — *Showing Composition of the Milk.*

		COWS.																	
		ADA (1).						UNA * OR GUERNSEY † (2).						BESSIE (3).					
		Total Solids (Per Cent.).	Nitrogen (Per Cent.).	N.×6.25 = Nitrogenous Matter (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Proportion of Fat to Solids not Fat	Total Solids (Per Cent.).	Nitrogen (Per Cent.).	N.×6.25 = Nitrogenous Matter (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Proportion of Fat to Solids not Fat.	Total Solids (Per Cent.).	Nitrogen (Per Cent.).	N.×6.25 = Nitrogenous Matter (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Proportion of Fat to Solids not Fat.
EXPERIMENT I.	Narrow ration,	12.92	-	-	4.24	8.68	1:2.05	14.34	-	-	4.53	9.81	1:2.17	13.34	-	-	4.36	8.98	1:2.06
		12.83	-	-	4.07	8.76	1:2.15	14.50	-	-	4.68	9.82	1:2.10	13.37	-	-	4.36	9.01	1:2.07
		13.03	-	-	4.11	8.92	1:2.17	13.78	-	-	4.15	9.63	1:2.32	13.10	-	-	4.22	8.88	1:2.10
	Average,	12.93	-	-	4.14	8.79	1:2.12	14.21	-	-	4.45	9.75	1:2.20	13.27	-	-	4.31	8.96	1:2.08
	Wide ration,	13.13	-	-	3.96	9.17	1:2.32	13.54	-	-	4.12	9.42	1:2.29	12.82	-	-	4.22	8.60	1:2.04
		13.30	-	-	4.20	9.10	1:2.17	13.87	-	-	4.35	9.52	1:2.19	12.60	-	-	4.22	8.36	1:1.97
		13.14	-	-	4.22	8.92	1:2.11	14.25	-	-	4.82	9.43	1:1.96	12.88	-	-	4.16	8.72	1:2.10
	Average,	13.19	-	-	4.13	9.06	1:2.20	13.89	-	-	4.43	9.46	1:2.14	12.77	-	-	4.21	8.56	1:2.04
EXPERIMENT II.	Narrow ration,	13.28	.497	3.11	4.26	9.02	1:2.12	14.50	.511	3.19	5.35	9.15	1:1.71	13.58	.509	3.18	4.78	8.80	1:1.84
		13.11	.493	3.08	4.41	8.70	1:1.97	14.30	.503	3.14	5.39	8.91	1:1.67	13.36	.508	3.17	4.58	8.78	1:1.92
		13.24	.497	3.11	4.25	8.99	1:2.11	14.25	.501	3.13	5.25	9.00	1:1.71	13.55	.522	3.26	4.60	8.95	1:1.95
	Average,	13.21	.496	3.10	4.31	8.90	1:2.07	14.35	.505	3.15	5.33	9.02	1:1.70	13.50	.513	3.20	4.65	8.85	1:1.90
	Wide ration,	13.41	.510	3.18	4.31	9.10	1:2.11	14.48	.526	3.29	5.30	9.18	1:1.73	13.98	.518	3.23	4.88	9.10	1:1.86
		13.49	.511	3.19	4.49	9.00	1:2.01	14.43	.499	3.11	5.53	8.90	1:1.61	14.21	.498	3.11	5.28	8.93	1:1.79
		13.50	.512	3.20	4.41	9.09	1:2.06	14.62	.508	3.17	5.63	8.99	1:1.60	14.05	.489	3.05	5.07	8.98	1:1.77
	Average,	13.47	.511	3.19	4.40	9.07	1:2.06	14.51	.511	3.19	5.49	9.02	1:1.65	14.08	.502	3.13	5.08	9.00	1:1.80

* In Experiment I.

† In Experiment II.

TABLE V. — *Concluded.*

		COWS.																	
		BEAUTY (4).						RED (5).						SPOT (6).					
		Total Solids (Per Cent.).	Nitrogen (Per Cent.).	N.×6.25=Nitrogenous Matter (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Proportion of Fat to Solids not Fat	Total Solids (Per Cent.).	Nitrogen (Per Cent.).	N.×6.25=Nitrogenous Matter (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Proportion of Fat to Solids not Fat.	Total Solids (Per Cent.).	Nitrogen (Per Cent.).	N.×6.25=Nitrogenous Matter (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Proportion of Fat to Solids not Fat
EXPERIMENT I.	Narrow ration, .	13.98	-	-	4.75	9.23	1:1.94	12.68	-	-	4.02	8.66	1:2.15	14.15	-	-	5.00	9.15	1:1.83
		14.68	-	-	5.19	9.49	1:1.83	12.86	-	-	4.18	8.68	1:2.08	14.17	-	-	4.81	9.36	1:1.94
		14.80	-	-	5.32	9.48	1:1.78	12.58	-	-	3.90	8.68	1:2.23	14.68	-	-	5.30	9.38	1:1.77
	Average, . .	14.40	-	-	5.09	9.40	1:1.85	12.71	-	-	4.03	8.68	1:2.15	14.33	-	-	5.04	9.29	1:1.84
	Wide ration, .	14.92	-	-	5.11	9.81	1:1.92	11.33	-	-	2.85	8.48	1:2.98	14.35	-	-	4.79	9.56	1:2.00
		14.89	-	-	5.13	9.76	1:1.90	11.10	-	-	2.97	8.13	1:2.74	14.80	-	-	5.22	9.58	1:1.83
		14.64	-	-	4.98	9.66	1:1.95	12.33	-	-	4.05	8.28	1:2.05	14.00	-	-	4.85	9.15	1:1.89
	Average, . .	14.82	-	-	5.07	9.75	1:1.92	12.33	-	-	4.05	8.28	1:2.05	14.38	-	-	4.95	9.43	1:1.91
EXPERIMENT II.	Narrow ration, .	14.63	.563	3.52	5.19	9.44	1:1.82	13.33	.468	2.92	4.95	8.38	1:1.69	13.33	.579	3.62	4.89	8.44	1:1.72
		14.62	.559	3.49	5.17	9.45	1:1.82	13.11	.522	3.26	4.39	8.72	1:1.98	14.36	.578	3.61	4.82	9.54	1:1.98
		14.68	.572	3.57	5.24	9.44	1:1.80	13.40	.511	3.19	4.62	8.78	1:1.90	14.34	.588	3.67	4.75	9.59	1:2.02
	Average, . .	14.64	.565	3.53	5.20	9.44	1:1.81	13.28	.500	3.12	4.65	8.63	1:1.86	14.01	.582	3.63	4.82	9.19	1:1.91
	Wide ration, .	14.92	.546	3.41	5.42	9.50	1:1.75	12.93	.455	2.84	4.37	8.56	1:1.96	14.67	.559	3.49	5.34	9.33	1:1.75
		14.95	.547	3.42	5.44	9.51	1:1.75	12.70	.472	2.95	4.21	8.49	1:2.02	14.96	.579	3.62	5.59	9.37	1:1.68
		14.80	.552	3.45	5.19	9.61	1:1.85	13.21	.468	2.92	4.62	8.59	1:1.86	14.81	.595	3.72	5.33	9.48	1:1.78
	Average, . .	14.89	.548	3.43	5.35	9.54	1:1.78	12.95	.465	2.90	4.40	8.55	1:1.95	14.81	.584	3.61	5.42	9.39	1:1.74

In judging the above results, it must not be forgotten that the entire lot of cows was not fed *at the same time* on either the wide or the narrow ration. For example, in Experiment I. cows I., IV. and VI. were first fed the narrow ration; while cows II., III. and V. were having at the same time the wide ration. It would be expected that cows I., IV. and VI. would naturally show slightly higher percentages on the wide ration, *because it was fed later;* and for a like reason cows II., III. and V. would show higher percentages on the narrow ration. In case of Cow V., on the wide ration, it has already been explained that the first two composite samples of milk show low solids, and less than 3 per cent. of fat. In the third sample both the solids and fat very noticeably increased. It is evident that this sudden change was not caused by feed; first, because the animal was in excellent flesh at the beginning of the experiment; and, second, because the change was a permanent one. The cow had been calved but a few weeks, and for some reason had not come to her average quality of milk. It was therefore considered advisable, in the wide ration, to omit in the average the first two analyses. With this exception, the first experiment shows very little variation in the quality of the milk. In the second experiment, cows I., II. and VI. were first fed the narrow ration, and cows III., IV. and V. first received the wide ration. All but Cow II. being somewhat advanced in the period of lactation, it is natural that at least cows I. and VI. should show slightly higher percentages with the wide ration, and cows III., IV. and V. with the narrow ration. This natural tendency is noticed in cows I., II., IV., V. and VI. One can therefore draw more reliable conclusions when the results from the six cows are averaged, thus eliminating as much as possible the error caused by natural shrinkage.

TABLE VI. — *Average Results from 6 Cows.*

Experiment I.

	Average Weight of Animals (Pounds).	Daily Digestible Nutrients consumed. Protein (Pounds).	Fat (Pounds).	Carbohydrates (Pounds).	Total Nutrients (Pounds).	Nutritive Ratio.	Composition of Milk. Total Solids (Per Cent.).	Nitrogenous Matter (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).
Narrow ration,	941	3.07	.59	10.23	14.06	1:3.86	13.66	-	4.51	9.15
Wide ration,	938	1.46	.52	12.45	14.43	1:9.43	13.56	-	4.47	9.09
Percentage increase narrow over wide.	-	-	-	-	-	-	+.73	-	+.89	+.66

Experiment II.

	Average Weight of Animals (Pounds).	Protein (Pounds).	Fat (Pounds).	Carbohydrates (Pounds).	Total Nutrients (Pounds).	Nutritive Ratio.	Total Solids (Per Cent.).	Nitrogenous Matter (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).
Narrow ration,	899	2.85	.65	9.96	13.46	1:4.04	13.83	3.29	4.83	9.00
Wide ration,	890	1.45	.54	11.44	13.42	1:8.85	14.12	3.24	5.02	9.10
Percentage increase narrow over wide.	-	-	-	-	-	-	−2.10	+1.52	−3.93	−1.11

The average weights of the animals during both periods of each experiment are practically identical. In the first experiment the milk appears to have suffered no change in composition. In the second experiment the wide ration seems to have slightly increased the solids and fat and diminished the nitrogenous matter. This is more strikingly brought out in Table VII.

TABLE VII. — *Showing Percentages on Basis of 14 Per Cent. Solids.*

	Experiment I. Fat (Per Cent.).	Experiment I. Solids not Fat (Per Cent.).	Experiment II. Nitrogenous Matter (Per Cent.)	Experiment II. Fat (Per Cent.).	Experiment II. Solids not Fat (Per Cent.).
Narrow ration,	4.62	9.38	3.33	4.88	9.11
Wide ration,	4.61	9.39	3.21	4.97	9.02
Percentage increase narrow over wide,	±	±	+3.60	−1.84	+ .99

In Table VII. it will be noticed that the wide ration, containing 1.45 pounds of digestible protein, .54 pound of digestible fat and 11.44 pounds of digestible carbohydrates, seemed to have produced a slight but noticeable increase in the percentage of fat; and the narrow ration, containing 2.85 pounds of digestible protein, .65 pound of digestible fat and 9.96 pounds of digestible carbohydrates, a slight increase in the total nitrogenous matter.

Recognizing the many serious difficulties in the way of securing results that will show *only* the influence of feed or feed constituents in the composition of milk, the writer would of course draw no positive conclusions, but simply present the figures as the results of two carefully conducted experiments along this line of investigation.

Complete Data of Experiments.

Table VIII. — *Total Feeds consumed, and Total Yield and Cost of Milk and Butter.*

Experiment I. Narrow Ration.

COW.	Feeds consumed.					Milk and Butter produced.				Cost of Milk and Butter.			
						Milk.		Butter.					
	Hay (Pounds).	Sugar Beets (Pounds).	Wheat Bran (Pounds).	Chicago Gluten Meal (Pounds).	Corn Meal (Pounds).	Total (Pounds).	Average Daily Yield (Pounds).	Total Butter Fat (Pounds).	Equal to Butter (Pounds).	Total Cost of Feeds consumed.	Cost of Feed per 100 Pounds of Milk (Cents).	Cost per Pound Butter Fat (Cents).	Cost per Pound Butter (Cents).
Ada,	312	312	78	130	-	655.2	25.2	27.13	31.65	$5 28	80.6	19.46	16.68
Una,	364	312	78	156	-	592.4	22.8	26.36	30.76	5 96	100.6	22.61	19.37
Bessie,	390	312	78	156	-	813.6	31.3	35.07	40.91	6 16	75.7	17.56	15.05
Beauty,	468	312	78	156	-	631.2	24.3	32.13	37.48	6 74	106.8	20.97	17.99
Red,	416	312	78	156	-	777.6	29.9	31.34	36.56	6 35	81.6	20.26	17.37
Spot,	416	312	78	156	-	771.5	29.7	38.87	45.35	6 35	82.4	16.32	14.00
Wide Ration.													
Ada,	338	312	78	-	130	559.3	21.5	23.10	26.95	$5 09	90.9	22.03	18.88
Una,	390	312	78	-	156	559.4	21.5	24.78	28.91	5 70	101.9	23.00	19.71
Bessie,	416	312	78	-	156	719.2	27.7	30.28	35.33	5 89	81.9	19.45	16.67
Beauty,	494	312	78	-	156	522.5	20.1	26.48	30.89	6 48	124.1	24.50	21.00
Red,	442	312	78	-	156	761.7	29.3	25.13	29.30	6 09	80.0	24.26	20.80
Spot,	442	312	78	-	156	573.9	22.1	28.41	33.14	6 09	106.1	21.44	18.38

TABLE IX. — *Total Feeds consumed, and Total Yield and Cost of Milk and Butter.*

Experiment II. Narrow Ration.

COW.	FEEDS CONSUMED.					MILK AND BUTTER PRODUCED.				COST OF MILK AND BUTTER.			
						MILK.		BUTTER.					
	Hay (Pounds).	Millet and Soy-bean Ensilage (Pounds).	Wheat Bran (Pounds).	Chicago Gluten Meal (Pounds).	Old-process Linseed Meal (Pounds).	Total (Pounds).	Average Daily Yield (Pounds).	Total Butter Fat (Pounds).	Equal to Butter (Pounds).	Total Cost of Feeds consumed.	Cost of Feed per 100 Pounds of Milk (Cents).	Cost per Pound Butter Fat (Cents).	Cost per Pound Butter (Cents).
Ada,	189	420	42	63	31.5	474.9	22.6	20.47	23.88	$3 68	76.4	17.70	15.90
Guernsey,	210	630	63	63	42	617.4	29.4	32.91	38.39	4 48	72.6	13.62	11.66
Bessie,	210	630	63	63	42	593.2	28.2	27.58	32.20	4 48	75.5	16.23	13.91
Beauty,	220	630	63	63	42	459.4	21.9	23.89	27.87	4 56	99.3	19.10	16.34
Red,	220	630	63	63	42	556.8	26.5	25.90	30.21	4 56	81.9	17.60	15.10
Spot,	220	630	63	63	42	559.0	26.6	26.94	31.43	4 56	81.5	16.93	14.52

Wide Ration.

COW.	Hay (Pounds).	Millet and Soy-bean Ensilage (Pounds).	Wheat Bran (Pounds).	*Corn Meal.*	Old-process Linseed Meal (Pounds).	Total (Pounds).	Average Daily Yield (Pounds).	Total Butter Fat (Pounds).	Equal to Butter (Pounds).	Total Cost of Feeds consumed.	Cost of Feed per 100 Pounds of Milk (Cents).	Cost per Pound Butter Fat (Cents).	Cost per Pound Butter (Cents).
Ada,	189	420	31.5	105	-	402.1	19.5	17.70	20.65	$3 34	83.1	18.87	16.21
Guernsey,	210	630	42	126	-	512.7	24.4	28.15	32.84	4 17	81.3	14.84	12.71
Bessie,	210	630	42	126	-	508.1	24.2	25.81	30.11	4 17	82.1	16.16	13.85
Beauty,	220	630	42	126	-	439.7	20.9	23.53	27.45	4 25	96.6	18.90	15.51
Red,	220	630	42	126	-	553.6	26.4	24.37	28.42	4 25	76.7	17.41	15.00
Spot,	220	630	42	126	-	461.3	22.0	25.00	29.17	4 25	92.2	17.00	14.55

TABLE X. — *Daily Feeds consumed.*

Experiment I. Narrow Ration.

COW.	Feeds consumed (Pounds) per Day.					Dry Matter consumed per Day (Pounds).	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbohydrates (Pounds).	Total Digestible Nutrients (Pounds).	Nutritive Ratio of Ration.	Weight at Beginning and End of Experiment (Pounds).	Average Weight (Pounds).
	Hay.	Sugar Beets.	Wheat Bran.	Chicago Gluten Meal.	Corn Meal.								
Ada,	12	12	3	5	-	19.24	2.66	.51	8.85	12.02	1:3.80	788-810	794
Una,	14	12	3	6	-	21.85	3.08	.58	10.00	13.66	1:3.72	870-900	905
Bessie,	15	12	3	6	-	22.75	3.12	.59	10.39	14.10	1:3.80	869-874	860
Beauty,	18	12	3	6	-	25.41	3.24	.63	11.59	15.46	1:4.03	1,037-1,055	1,038
Red,	16	12	3	6	-	23.59	3.16	.61	10.77	14.54	1:3.90	1,040-1,058	1,061
Spot,	16	12	3	6	-	23.65	3.16	.61	10.79	14.56	1:3.90	1,000-1,008	987
Wide Ration.													
Ada,	13	12	3	-	5	20.13	1.29	.45	10.68	12.42	1:9.16	805-801	807
Una,	14.50	12	3	-	6	22.30	1.40	.51	11.91	13.82	1:9.40	894-884	888
Bessie,	16	12	3	-	6	23.67	1.46	.53	12.53	14.52	1:9.50	890-862	867
Beauty,	19	12	3	-	6	26.22	1.57	.56	13.57	15.70	1:9.54	1,045-1,033	1,044
Red,	17	12	3	-	6	24.55	1.50	.54	12.93	14.97	1:9.52	1,020-1,038	1,025
Spot,	17	12	3	-	6	24.48	1.50	.54	12.88	14.92	1:9.49	1,010-982	995

TABLE XI. — *Daily Feeds consumed.*

Experiment II. Narrow Ration.

COW.	Feeds consumed Daily (Pounds).						Dry Matter consumed Daily (Pounds).	Digestible Matter consumed Daily (Pounds).				Nutritive Ratio of Ration.	Weight at Beginning and End of Experiment (Pounds).	Average Weight (Pounds).
	Hay.	Millet and Soy-bean Ensilage.	Wheat Bran.	Chicago Gluten Meal.	Linseed Meal.	Corn Meal.		Protein.	Fat.	Carbohydrates.	Total Nutrients.			
Ada,	9	20	2	3	1.5	-	17.43	2.41	.52	8.05	10.98	1:3.9	770-762	763
Guernsey,	10	30	3	3	2	-	21.49	2.89	.66	9.88	13.43	1:4.0	862-860	861
Bessie,	10	30	3	3	2	-	22.15	2.93	.67	10.21	13.81	1:4.0	835-822	828
Beauty,	11	30	3	3	2	-	23.05	2.98	.68	10.65	14.31	1:4.1	995-975	981
Red,	11	30	3	3	2	-	23.05	2.98	.68	10.65	14.31	1:4.1	1,022-1,022	1,017
Spot,	11	30	3	3	2	-	22.37	2.98	.67	10.32	13.97	1:4.1	948-940	943

Wide Ration.

COW.	Hay.	Millet and Soy-bean Ensilage.	Wheat Bran.	Chicago Gluten Meal.	Linseed Meal.	Corn Meal.	Dry Matter consumed Daily (Pounds).	Protein.	Fat.	Carbohydrates.	Total Nutrients.	Nutritive Ratio of Ration.	Weight at Beginning and End of Experiment (Pounds).	Average Weight (Pounds).
Ada,	9	20	1.5	-	-	5	17.63	1.20	.44	9.58	11.22	1:8.90	775-770	772
Guernsey,	10	30	2	-	-	6	21.80	1.50	.56	11.74	13.80	1:8.76	850-835	838
Bessie,	10	30	2	-	-	6	21.12	1.44	.55	11.41	13.40	1:8.88	814-835	824
Beauty,	11	30	2	-	-	6	22.00	1.49	.56	11.85	13.90	1:8.89	970-966	958
Red,	11	30	2	-	-	6	22.00	1.49	.56	11.85	13.90	1:8.89	1,011-1,007	1,004
Spot,	11	30	2	-	-	6	22.70	1.55	.57	12.18	14.30	1:8.78	940-945	942

TABLE XII. — *Showing Total Amount of Dry and Digestible Matter consumed, and Total Milk Products produced.*

Experiment I.

CHARACTER OF RATION.	Dry Matter consumed (Pounds).	Digestible Matter consumed (Pounds).	Milk produced (Pounds).	Milk Solids produced (Pounds).	Milk Fat produced (Pounds).
Narrow, ...	3,549.0	2,193.4	4,241.5	579.4	191.3
Wide, ...	3,675.4	2,251.1	3,695.5	501.1	165.2

Experiment II.

CHARACTER OF RATION.	Dry Matter consumed (Pounds).	Digestible Matter consumed (Pounds).	Milk produced (Pounds).	Milk Solids produced (Pounds).	Milk Fat produced (Pounds).
Narrow, ...	2,721.6	1,696.0	3,261.0	451.0	157.5
Wide, ...	2,671.2	1,691.0	2,877.0	406.2	144.4

TABLE XIII. — *Showing for Every 100 Pounds of Dry and Digestible Matter consumed, Amounts of Milk, Milk Solids and Milk Fat produced.*

Narrow Ration.

ONE HUNDRED POUNDS.	EXPERIMENT I.			EXPERIMENT II.		
	Milk (Pounds).	Milk Solids (Pounds).	Fat (Pounds).	Milk (Pounds).	Milk Solids (Pounds).	Fat (Pounds).
Dry matter produced, ...	119.51	16.32	5.39	119.8	16.6	5.8
Digestible matter produced, . . .	193.41	26.42	8.72	192.3	26.6	9.3

Wide Ration.

ONE HUNDRED POUNDS.	EXPERIMENT I.			EXPERIMENT II.		
	Milk (Pounds).	Milk Solids (Pounds).	Fat (Pounds).	Milk (Pounds).	Milk Solids (Pounds).	Fat (Pounds).
Dry matter produced, ...	100.28	13.74	4.48	107.7	15.4	5.40
Digestible matter produced, . . .	164.16	22.28	7.34	170.1	24.0	8.54

TABLE XIV. — *Pounds of Digestible Matter required to produce 100 Pounds of Milk, a Pound of Milk Solids and a Pound of Butter.*

Narrow Ration.

POUNDS REQUIRED OF —	EXPERIMENT I. TO PRODUCE —			EXPERIMENT II. TO PRODUCE —		
	100 Pounds Milk.	One Pound Milk Solids.	One Pound Butter.	100 Pounds Milk.	One Pound Milk Solids.	One Pound Butter.
Digestible matter, ...	51.7	3.78	9.83	52.0	3.76	9.2

Wide Ration.

Digestible matter, ...	60.9	4.49	11.68	58.8	4.16	10.04

TABLE XV. — *Composition of Feeds (Dry Matter).*

Experiment I.

	Hay (Per Cent.).	Digestion Coefficients.	Sugar Beets (Per Cent.).	Digestion Coefficients.	Millet and Soy-bean Ensilage (Per Cent.).	Digestion Coefficients.	Wheat Bran (Per Cent.).	Digestion Coefficients.	Chicago Gluten Meal (Per Cent.).	Digestion Coefficients.	Old-process Linseed Meal (Per Cent.).	Digestion Coefficients.	Corn Meal (Per Cent.).	Digestion Coefficients.	Waste (Cow II., Wide Ration).*
Ash,	6.02	-	9.16	-	-	-	5.77	-	1.16	-	-	-	1.43	-	5.10
Fiber,	33.13	47	8.58	-	-	-	11.63	22	3.12	-	-	-	2.06	-	43.66
Fat,	2.65	53	.63	-	-	-	5.64	71	5.96	93	-	-	4.46	92	1.58
Protein,	9.73	45	8.65	62	-	-	19.20	78	42.73	89	-	-	11.36	60	6.21
Extract matter,	48.47	60	72.98	98	-	-	57.76	68	47.03	93	-	-	80.69	93	43.45

Experiment II.

	Hay (Per Cent.).	Digestion Coefficients.	Sugar Beets (Per Cent.).	Digestion Coefficients.	Millet and Soy-bean Ensilage (Per Cent.).	Digestion Coefficients.	Wheat Bran (Per Cent.).	Digestion Coefficients.	Chicago Gluten Meal (Per Cent.).	Digestion Coefficients.	Old-process Linseed Meal (Per Cent.).	Digestion Coefficients.	Corn Meal (Per Cent.).	Digestion Coefficients.	Waste (Cow II., Wide Ration).*
Ash,	5.32	-	-	-	10.55	-	6.41	-	.90	-	4.94	-	1.27	-	-
Fiber,	32.27	60	-	-	36.07	69	11.03	22	3.63	-	7.26	50	2.44	-	-
Fat,	2.72	49	-	-	4.25	72	5.62	71	6.06	93	7.05	89	4.12	92	-
Protein,	9.21	59	-	-	12.01	57	18.87	78	39.75	89	41.99	89	11.36	60	-
Extract matter,	50.48	59	-	-	37.12	59	58.07	68	49.66	93	38.76	78	80.80	93	-

* Amounting to 14.75 pounds and containing 85 per cent. of dry matter.

TABLE XVI. — *Dry Matter Determinations.*

Experiment I.

	Hay (Per Cent.).	Sugar Beets (Per Cent.).	Millet and Soy-bean Ensilage (Per Cent.).	Wheat Bran (Per Cent.).	Chicago Gluten Meal (Per Cent.).	Old-process Linseed Meal (Per Cent.).	Corn Meal (Per Cent.).
October 24 to November 19,	87.5	13.00	-	88.3	91.0	-	87.7
November 28 to December 24,	87.0	14.70	-	88.6	91.0	-	87.7

Experiment II.

January 27 to February 17,	88 0	-	18.4	88.0	91.0	90.0	84.5
February 29 to March 21,	91.0	-	19.7	88.0	91.0	90.0	84.5

Market Cost of Feed Stuffs per Ton.

	Experiment I.	Experiment II.
Hay,	$15 00	$15 00
Sugar beets,	5 00	-
Millet and soy-bean ensilage,	-	4 00
Wheat bran,	17 00	16 00
Chicago gluten meal,	23 00	22 00
Linseed meal,	-	22 00
Corn meal,	17 00	16 00

FEEDING EXPERIMENTS WITH PIGS.

(*b*) Rice Meal *v.* Corn Meal.

Experiment I. — *Nov. 12, 1895, to Feb. 11, 1896.*

Results.

Three pigs fed rice meal and skim-milk each showed an average weight of 67 pounds at the beginning of the experiment and 195.2 pounds at the end of the experiment; the three fed corn meal and skim-milk each showed an average weight of 65 pounds at the beginning and 193.5 pounds at the end of the experiment.

The rice meal lot consumed during the experiment 3,519 pounds of skim-milk (1,614 quarts), together with 867 pounds of rice meal, and gained 385 pounds of live weight, equal to 298 pounds of dressed weight; the corn meal lot consumed like quantities of milk and corn meal, and gained 385 pounds of live weight, equal to 309 pounds of dressed weight.

The rice meal lot consumed 1,118.64 pounds of dry matter and the corn meal lot 1,105.65 pounds of dry matter.

The rice meal lot required 2.91 pounds of dry matter to produce 1 pound of live weight and 3.77 pounds to produce 1 pound of dressed weight; the corn meal lot required 2.91 pounds of dry matter to produce 1 pound of live weight and 3.59 pounds to produce 1 pound of dressed weight.

The average daily gain in live weight of each pig in both the rice and corn meal lots was 1.41 pounds.

The three pigs fed rice meal showed an average shrinkage of 22.64 per cent. in dressing; the corn meal fed pigs shrank 20 per cent.

The above results indicate that a good quality of rice meal has a feeding value equal to a similar quality of corn meal.

With grain at $18 per ton and dressed pork at 5 cents per pound, skim-milk returned ½ of a cent per quart, or 23 cents

per 100 pounds; with the same price for grain and dressed pork at 6 cents per pound, skim-milk would return 31.5 cents per 100 pounds.

With grain at $18 per ton and skim-milk at 15 cents per 100 pounds, live weight would cost 2.88 cents per pound and dressed weight 3.66 cents. If skim-milk were reckoned at 25 cents per 100 pounds, live weight would cost 4 cents per pound and dressed weight 5 cents per pound.

Details of the Experiment.

The object of the experiment was to compare the nutritive effect of rice meal with corn meal when fed in connection with skim-milk. Six pigs, grade Chester White, all out of the same litter, were selected. They were received October 15, when six weeks old, and kept for a month before beginning the experiment. Before starting the experiment each pig was placed in a separate pen, of about 100 feet area. The pens were separated by heavy galvanized wire, thus securing good ventilation, and allowing at the same time the animals to see each other. While they had no outdoor run, the pens were large, the room airy and well lighted, and the constant good health of the animals indicated no disturbing influences. Only in very severe weather did the temperature in the building fall a little below freezing.

Feeding. — The animals were fed three times daily, the slightly warmed milk being measured, and the grain ration for the twenty-four hours accurately weighed. The pigs were each given from 5 to 6 quarts of milk daily. At the beginning of the experiment 4 ounces of grain were given with each quart of milk; and the amount increased from time to time, to suit the appetites of the animals. The feed was consumed during the entire time, without a single refusal.

Feeds. — The skim-milk was tested occasionally, and 9.75 per cent. of solids were used in calculating the amount of dry matter it contained. Rice meal is fed and highly prized in Europe. It is occasionally found in our markets, but the present low price of corn meal excludes it. In preparing rice for human consumption, various mechanical processes are employed. After the hull is removed, the rice is

brought into mortars holding from 4 to 6 bushels each and pounded, to remove the yellow, gluey covering of the grain and give it the creamy color so much desired. This pounding really removes the chaff and some of the flour, and leaves the grain but little broken. The rice is then polished to give it a pearly lustre, which is effected by friction of the grains of rice against tanned moose hide. That portion rubbed off is termed rice polish. The chaff and flour above referred to, and in some cases the polish also, are mixed and sold as rice meal for cattle feeding.

Composition.

[Figures equal percentages or pounds per 100.]

	Rice Meal.	Corn Meal.
Water,	10.50	12.00
Ash,	7.67	1.42
Fiber,	5.03	1.84
Fat,	12.10	3.34
Protein,	12.95	9.68
Extract matter,	51.75	71.72

The above feeds have the same type of composition, being comparatively low in protein and high in carbohydrates. They both may be termed heat-producing and fattening feeds. The rice meal contains more fat and less extract or starchy matter than the corn meal.

Data of the Experiment (Nov. 12, 1895, to Feb. 12, 1896).

LOT I. — *Rice Meal.*

NUMBER OF PIG.	Skim-milk consumed.			Grain consumed.			Weight at Beginning of Experiment (Pounds).	Weight at End of Experiment (Pounds).	Gain in Live Weight (Pounds).	Daily Gain in Live Weight (Pounds).	Loss of Weight in Dressing (Per Cent.).	Computed Dressed Weight at Beginning of Experiment (Pounds).	Dressed Weight at End of Experiment (Pounds).	Gain in Dressed Weight (Pounds).	Dry Substance used to produce One Pound Live Weight (Pounds).	Dry Substance used to produce One Pound Dressed Weight (Pounds).
	Quarts.	Pounds.	Dry Matter (Pounds).	Corn Meal (Pounds).	Rice Meal (Pounds).	Dry Matter (Pounds).										
I, ...	538	1,172.8	114.35	-	288.87	258.5	67.25	187.00	119.75	1.32	22.86	51.88	144.25	92.37	3.11	4.04
II., ...	538	1,172.8	114.35	-	288.87	258.5	67.25	199.25	132.00	1.45	23.46	51.47	152.50	101.03	2.82	3.69
III., ...	538	1,172.8	114.35	-	288.87	258.5	67.00	200.25	132.25	1.46	21.59	52.53	157.00	104.47	2.80	3.57
Total, . . .	1,614	3,518.5	343.05	-	866.60	775.6	201.50	586.50	385.00	4.23	-	155.88	453.75	297.81	-	-
Average per pig, .	538	1,172.8	114.35	-	288.87	258.5	67.00	195.20	128.30	1.41	22.64	51.96	151.28	99.37	2.91	3.77

LOT II. — *Corn Meal.*

NUMBER OF PIG.	Quarts.	Pounds.	Dry Matter (Pounds).	Corn Meal (Pounds).	Rice Meal (Pounds).	Dry Matter (Pounds).	Weight at Beginning of Experiment (Pounds).	Weight at End of Experiment (Pounds).	Gain in Live Weight (Pounds).	Daily Gain in Live Weight (Pounds).	Loss of Weight in Dressing (Per Cent.).	Computed Dressed Weight at Beginning of Experiment (Pounds).	Dressed Weight at End of Experiment (Pounds).	Gain in Dressed Weight (Pounds).	Dry Substance used to produce One Pound Live Weight (Pounds).	Dry Substance used to produce One Pound Dressed Weight (Pounds).
I., ...	538	1,172.8	114.35	288.87	-	254.20	67.00	192.50	125.50	1.38	19.74	53.77	154.50	100.73	2.94	3.66
II., ...	538	1,172.8	114.35	288.87	-	254.20	58.75	184.50	125.75	1.41	20.73	46.57	146.25	99.68	2.93	3.70
III., ...	538	1,172.8	114.35	288.87	-	254.20	69.25	203.50	134.25	1.48	19.41	55.81	164.00	108.19	2.74	3.41
Total, . . .	1,614	3,518.5	343.05	866.60	-	762.60	195.00	580.50	385.50	4.27	-	156.15	464.75	308.60	-	-
Average per pig, .	538	1,172.8	114.35	288.87	-	254.20	65.00	193.50	128.50	1.42	19.96	52.05	154.92	102.90	2.90	3.59

Additional Data.

In order to throw light on the price returned for skim-milk and the cost of feed required to produce a pound of live and dressed weight, the following additional data is presented, and the amount of feed consumed is reckoned from October 15, when the pigs were received, to February 12, when they were slaughtered. The results below are based on the entire lot of six pigs.

	Quarts.	Pounds.
Total milk consumed by six pigs,	4,092	8,921
Total grain consumed by six pigs,	-	1,920
Live weight actually gained,	-	968
Dressed weight actually gained,	-	762

PRICE RETURNED FOR SKIM-MILK.	WHEN CORN MEAL SELLS AT $18 PER TON AND DRESSED PORK AT —				WHEN CORN MEAL SELLS AT $24 PER TON AND DRESSED PORK AT —			
	Five Cents.	Six Cents.	Seven Cents.	Eight Cents.	Five Cents.	Six Cents.	Seven Cents.	Eight Cents.
Per quart (fraction of cent),	.50	.69	.87	1.06	.36	.54	.73	.91
Per 100 pounds (cents),	23.00	31.50	40.00	48.50	16.00	25.00	33.00	42.00

The pigs were six weeks old when they were received, and weighed about 33 pounds each. When slaughtered they averaged 194.5 pounds each. The pigs made a rapid growth, and the results are fully as favorable as could be hoped for.

Cost of Feed per Pound of Growth produced (Cents).

	Live Weight.	Dressed Weight.
When corn meal costs $18 per ton and milk ¼ cent per quart,	2.88	3.66
When corn meal costs $18 per ton and milk ½ cent per quart,	4.00	5.00
When corn meal costs $24 per ton and milk ¼ cent per quart,	3.48	4.43
When corn meal costs $24 per ton and milk ½ cent per quart,	4.55	5.80

(c) Oat Feed v. Corn Meal for Pigs.

Experiment II. — *March 29 to June 30, 1896.*

Results.

Four pigs fed oat feed and skim-milk each showed an average weight of 42.56 pounds at the beginning and 136.75 pounds at the end of the experiment; the two fed corn meal and milk showed an average weight of 45.25 pounds at the beginning and 157.70 pounds at the end of the experiment.

The oat feed lot consumed during the experiment 5,389 pounds of skim-milk (2,474 quarts), together with 869 pounds of oat feed, and gained 376.75 pounds of live weight, an average gain of 94.19 pounds each; the corn meal lot consumed 2,694.5 pounds of milk (1,236 quarts), together with 435 pounds of corn meal, and gained 225.25 pounds, or an average gain of 112.62 pounds.

The oat feed lot consumed 1,305.96 pounds of dry matter and required 3.47 pounds of dry matter to produce a pound of live weight; the corn meal lot consumed 645.1 pounds of dry matter and required 2.86 pounds of dry matter to produce a pound of live weight.

The oat feed lot showed an average daily gain of 1.03 pounds in live weight, and the corn meal lot a daily gain of 1.22 pounds in live weight.

The present experiment shows that only 83.6 per cent. as much pork was produced with oat feed as with an equal weight of corn meal, or 100 pounds of corn meal were equal to 120 pounds of oat feed.

With corn meal at $18 per ton, oat feed at $16 per ton and dressed pork at 5 cents per pound, skim-milk returned $\frac{1}{3}$ of a cent per quart, or 15.6 cents per 100 pounds in case of the entire lot of six pigs.

With the same price for grain and skim-milk reckoned at $\frac{1}{4}$ cent per quart, live weight would cost 3.34 cents and dressed weight 4.3 cents per pound. Further details concerning prices will be found in the description of the experiment.

Details of Experiment II.

The object of this experiment was to compare the nutritive effect of corn meal with oat feed. Six grade Chester White pigs, all from the same litter, were used. The pigs were kept in the same pens and handled in the same way as described in the previous experiment. They had been in the pens over a month before the experiment began.

Feeding.— The pigs were each fed at the beginning 5 quarts of milk together with 3 ounces of meal to each quart of milk, and increased in this proportion till 8 quarts of milk were fed; the grains were then still further increased from time to time to satisfy the appetites of the animals.

Feeds.— The skim-milk and corn meal were of the same average quality as reported in the previous experiment. Oat feed is the refuse from factories engaged in the preparation of oat meal for human consumption. It consists of the poor oats, oat hulls and some of the bran and starch which are removed in the process of manufacture. It is, as the corn meal, a heat-producing rather than a flesh-forming feed. Oat feed varies very much in composition, and consequently in feeding value. The sample used may be considered an average one.

Composition.

[Figures equal percentages or pounds per 100.]

	Oat Feed.	Corn Meal.
Water,	10.00	12.00
Ash,	5.00	1.42
Fiber,	14.75	1.84
Fat,	3.72	3.34
Protein,	12.19	9.68
Extract matter,	54.34	71.72

The presence of the high percentage of fiber in the oat feed is indicative of a considerable amount of hulls.

Data of the Experiment (March 29 to June 30, 1896).

LOT I. — *Oat Feed.*

NUMBER OF PIG.	Skim-milk consumed.			Grains consumed.			Live Weight at Beginning of Experiment (Pounds).	Live Weight at End of Experiment (Pounds).	Total Gain in Live Weight (Pounds).	Daily Gain in Live Weight (Pounds).	Dry Matter needed to produce a Pound of Live Weight (Pounds).
	Quarts.	Pounds.	Dry Matter (Pounds).	Oat Feed (Pounds).	Corn Meal (Pounds).	Dry Matter (Pounds).					
I.,	618	1,347.24	131.36	217.3	-	195.13	46.75	140.75	94.00	1.02	3.47
II.,	618	1,347.24	131.36	217.3	-	195.13	35.75	121.75	86.00	.94	3.89
III.,	618	1,347.24	131.36	217.3	-	195.13	43.50	143.75	100.25	1.09	3.26
IV.,	618	1,347.24	131.36	217.3	-	195.13	44.25	140.75	96.50	1.05	3.38
Total,	2,472	5,388.96	525.44	869.2	-	780.52	170.25	547.00	376.75	-	-
Average per pig,	618	1,347.24	131.36	217.3	-	195.13	42.56	136.75	94.19	1.03	3.50

LOT II. — *Corn Meal.*

NUMBER OF PIG.	Quarts.	Pounds.	Dry Matter (Pounds).	Oat Feed (Pounds).	Corn Meal (Pounds).	Dry Matter (Pounds).	Live Weight at Beginning of Experiment (Pounds).	Live Weight at End of Experiment (Pounds).	Total Gain in Live Weight (Pounds).	Daily Gain in Live Weight (Pounds).	Dry Matter needed to produce a Pound of Live Weight (Pounds).
V.,	618	1,347.24	131.36	-	217.3	191.20	43.25	154.57	111.50	1.21	2.89
VII.,	618	1,347.24	131.36	-	217.3	191.20	47.25	160.75	113.75	1.24	2.84
Total,	1,236	2,694.48	262.72	-	434.6	382.40	90.50	315.50	225.25	-	-
Average per pig,	618	1,347.24	131.36	-	217.3	191.20	45.25	157.70	112.62	1.22	2.86

Additional Data.

In order to show the price returned for skim-milk and the cost of feed required to produce a pound of live and dressed weight, the additional data is presented for the six pigs : —

	Quarts.	Pounds.
Total milk consumed by six pigs, ...	3,708	8,083.5
Total oat feed consumed by six pigs, ...	–	869.0
Total corn meal consumed by six pigs, ...	–	435.0
Live weight actually gained, ...	–	602.0
Dressed weight calculated, ...	–	470.0

PRICE RETURNED FOR SKIM-MILK.	WITH OAT FEED AT $16 PER TON, CORN MEAL AT $18 PER TON AND DRESSED PORK AT —				WITH OAT FEED AT $21 PER TON, CORN MEAL AT $24 PER TON AND DRESSED PORK AT —			
	Five Cents.	Six Cents.	Seven Cents.	Eight Cents.	Five Cents.	Six Cents.	Seven Cents.	Eight Cents.
Per quart (fraction of cent), . . .	.34	.47	.60	.72	.25	.37	.50	.62
Per 100 pounds (cents),	15.60	21.40	27.00	33.00	11.00	17.00	23.00	29.00

The pigs did not grow as rapidly as in the first experiment, and consequently the returns are below those obtained with the previous lot. The animals seemed inferior, and unable to turn the feed into rapid growth. The above figures are more nearly what might be expected by the average farmer.

Cost of Feed per Pound of Growth produced (Cents).

	Live Weight.	Dressed Weight.
With grain prices at $16 and $18 and milk at ¼ cent per quart, .	3.34	4.30
With grain prices at $16 and $18 and milk at ½ cent per quart, .	4.88	6.25
With grain prices at $21 and $24 and milk at ¼ cent per quart, .	3.90	5.00
With grain prices at $21 and $24 and milk at ½ cent per quart, .	5.46	7.00

(*d*) Digestion Experiments with Sheep.

We have continued our digestion studies of the various cattle feeds during the past year. Some of the work undertaken is as yet incomplete, and experiments are still in progress. Below is presented the digestion coefficients obtained with several feed stuffs. The entire data will be presented at another time. By digestion coefficients is meant the percentage of the several groups of constituents composing feed stuffs that the animal is capable of digesting. Thus, if wheat bran contains 16 per cent. of protein, or 16 pounds in 100, and the coefficient of the protein digestibility is 78, this means that the animal can digest 78 per cent. of the 16 pounds, or 12.48 pounds.

Digestion Coefficients obtained.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Fiber (Per Cent.).	Fat (Per Cent.).	Protein (Per Cent.).	Extract Matter (Per Cent.).
Rice meal,	1	2	74	(?)	91	62	92
Pope gluten feed,	1	2	87	77	81	86	90
Pope gluten meal,	1	2	93	(?)	98	84	88
Millet and soy-bean ensilage,	1	4	59	69	72	57	59
Corn and soy-bean ensilage,	1	3	69	65	82	65	75
Hay (mostly timothy),	1	2	55	57	57	54	55

Compilation of Analyses of Fodder Articles and Dairy Products,

made at

AMHERST, MASS.

1868-1897.

Prepared by E. B. Holland.

A. Fodder Articles.

B. Fertilizing Ingredients in Fodders.

C. Dairy Products.

A. Composition and Digestibility of Cattle Feeds.

[Figures equal percentages or pounds in 100.]

NAME.	Analyses.	Composition. Fresh or air-dry substance.						Composition. Water-free substance.				Digestibility. Fresh or air-dry substance.				Digestibility. Water-free substance.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
I. Green Fodders.																			
Corn fodder,	33	75.	1.2	5.2	0.5	2.0	16.1	20.8	2.0	8.0	64.4	2.7	0.4	1.1	12.1	10.6	1.6	4.3	48.3
Sorghum,	6	83.	1.2	4.6	0.3	1.5	9.4	27.0	1.8	8.8	55.3	2.7	0.2	0.7	7.0	15.9	1.3	4.0	41.0
Common millet,	9	65.	1.7	11.0	1.0	2.6	18.7	31.4	2.9	7.4	53.4	–	–	–	–	–	–	–	–
Japanese millet (*Panicum italicum*),	12	75.	1.5	7.8	0.5	2.1	13.1	31.2	2.0	8.2	52.5	–	–	–	–	–	–	–	–
Panicum miliaceum,	1	69.	1.7	8.2	1.2	1.8	18.1	26.5	3.8	5.8	58.4	–	–	–	–	–	–	–	–
Barn-yard millet (*Panicum crus-galli*),	2	75.	1.9	7.0	0.6	2.4	13.1	27.9	2.5	9.7	52.2	–	–	–	–	–	–	–	–
Summer rape,	1	86.	2.6	2.5	0.5	2.0	6.4	17.8	3.6	14.3	45.7	–	–	–	–	–	–	–	–
Winter rape,	1	86.	3.1	1.7	0.5	2.1	6.6	12.1	3.6	15.0	47.1	–	–	–	–	–	–	–	–
Dwarf Essex rape,	1	86.	2.2	2.7	0.6	1.8	6.7	19.3	4.3	12.9	47.8	–	–	–	–	–	–	–	–
Green oats,	6	74.	2.1	7.8	0.8	3.6	11.7	30.0	3.1	13.8	45.0	4.4	0.5	2.5	8.5	16.8	1.9	9.7	32.9
Green barley,	1	79.	1.8	7.9	0.6	2.7	8.0	37.6	2.8	12.9	38.1	4.4	0.4	1.9	5.8	21.1	1.7	9.0	27.8
Green rye,	2	72.	1.6	8.9	0.6	2.1	14.8	31.8	2.1	7.5	52.9	5.0	0.4	1.5	10.8	17.8	1.3	5.3	38.6
Timothy,	2	65.	1.7	11.3	0.7	3.2	18.1	32.3	2.0	9.1	51.7	5.9	0.4	1.5	11.4	16.8	1.2	4.4	32.6

Hungarian grass,	2	74.	2.1	7.0	0.5	2.6	13.8	26.9	1.9	10.0	53.1	4.8	0.3	1.6	9.1	18.3	1.0	6.2	35.0
Vetch and oats (1 to 1),	1	82.	1.7	5.4	0.5	3.0	7.4	30.0	2.8	16.7	41.1	-	-	-	-	-	-	-	-
Vetch and oats (1 to 4),	1	79.	1.9	6.3	0.8	2.8	9.2	30.0	3.8	13.3	43.8	-	-	-	-	-	-	-	-
Peas and oats,	2	84.	1.3	4.7	0.5	2.4	7.1	29.4	3.1	15.0	44.4	2.8	0.2	1.8	4.3	17.6	1.4	11.6	27.1
Barley and peas,	1	84.	1.3	5.4	0.5	2.2	6.6	33.8	3.1	13.8	41.2	3.2	0.2	1.7	4.0	20.3	1.4	10.6	29.1
Horse bean,	1	85.	0.9	4.3	0.4	2.5	6.9	28.6	2.7	16.7	46.0	-	-	-	-	-	-	-	-
Flat pea,	2	79.	1.9	5.2	0.9	6.1	6.9	24.8	4.3	29.0	32.9	-	-	-	-	-	-	-	-
Cow pea,	3	82.	1.7	3.9	0.7	3.1	8.6	21.7	3.9	17.2	47.8	-	-	-	-	-	-	-	-
Soy bean,	14	76.	2.5	6.5	1.1	4.2	9.7	27.1	4.6	17.5	40.4	3.7	0.3	3.0	6.7	16.5	1.3	12.4	27.9
Soy bean (early white),	4	70.	3.9	6.7	0.8	5.0	13.6	22.3	2.7	16.7	45.3	-	-	-	-	-	-	-	-
Soy bean (medium green),	1	70.	3.9	7.1	1.2	5.8	12.0	23.7	4.0	19.3	40.0	-	-	-	-	-	-	-	-
Soy bean (medium black)	2	75.	3.1	5.9	1.3	4.7	10.0	23.4	5.2	18.9	39.9	-	-	-	-	-	-	-	-
Soy bean (late),	4	74.	3.5	5.5	0.7	5.9	10.4	21.1	2.7	22.7	40.0	-	-	-	-	-	-	-	-
Bokhara or sweet clover,	3	79.	2.1	6.3	0.6	4.2	7.8	30.0	2.9	20.0	37.1	-	-	-	-	-	-	-	-
Serradella,	3	82.	1.9	5.3	0.4	2.6	7.8	29.5	2.2	14.4	43.3	-	-	-	-	-	-	-	-
Common vetch,	2	82.	1.5	5.5	0.4	2.7	7.9	30.6	2.2	15.0	43.9	-	-	-	-	-	-	-	-
Hairy vetch,	1	82.	1.5	5.7	0.2	3.6	7.0	31.6	1.1	20.0	38.9	-	-	-	-	-	-	-	-
Kidney vetch,	1	81.	2.6	2.9	0.7	3.5	9.3	15.3	3.7	18.4	48.9	-	-	-	-	-	-	-	-
Prickly comfrey,	1	87.	2.8	1.5	0.3	2.3	6.1	11.5	2.4	17.7	46.9	-	-	-	-	-	-	-	-
Spurry,	1	72.	2.6	7.0	0.1	2.9	15.4	25.0	0.4	10.3	55.0	-	-	-	-	-	-	-	-
Scotch tares,	1	82.	2.2	5.1	0.3	3.5	6.9	28.3	1.7	19.5	38.3	-	-	-	-	-	-	-	-

A. Composition and Digestibility of Cattle Feeds — Continued.

NAME.	Analyses.	COMPOSITION. Fresh or Air-Dry Substance. Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	COMPOSITION. Water-Free Substance. Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	DIGESTIBILITY. Fresh or Air Dry Substance. Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	DIGESTIBILITY. Water-Free Substance. Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
II. Ensilages.																			
Corn ensilage,	39	78.	1.2	6.0	0.8	1.9	12.1	27.3	3.6	8.6	55.0	4.1	0.6	1.0	8.0	18.6	2.8	4.6	37.9
Corn and soy-bean ensilage,	4	76.	2.4	7.2	0.8	2.5	11.1	30.0	3.3	10.4	46.3	4.7	0.7	1.6	8.3	19.5	2.7	6.8	34.7
Millet ensilage,	3	74.	2.4	7.5	0.8	1.7	13.6	28.8	3.1	6.5	52.3	-	-	-	-	-	-	-	-
Millet and soy-bean ensilage,	9	79.	2.8	7.2	1.0	2.8	7.2	34.3	4.8	13.3	34.3	-	-	-	-	-	-	-	-
Apple-pomace ensilage,	1	85.	0.6	3.3	1.1	1.2	8.8	22.0	7.3	8.0	58.7	-	-	-	-	-	-	-	-
III. (a) Hay and Dry Coarse Fodders.																			
Corn fodder,	4	20.	4.1	23.4	1.4	6.2	44.9	29.2	1.7	7.7	56.3	15.2	1.0	3.7	33.2	19.0	1.3	4.5	41.7
Corn stover,	30	20.	4.7	28.3	1.1	5.9	40.0	35.4	1.4	7.3	50.0	19.0	0.6	3.1	25.6	23.7	0.7	3.8	32.0
English hay (mixed grasses),	66	14.	5.3	26.9	2.4	8.1	43.3	31.3	2.8	9.4	50.3	16.1	1.2	4.8	25.5	18.8	1.4	5.5	29.7
Fermented hay,	1	14.	6.3	25.4	2.2	8.4	43.7	29.5	2.6	9.8	50.8	-	-	-	-	-	-	-	-
Canada hay,	4	14.	4.6	28.1	2.1	6.1	45.1	32.7	2.4	7.1	52.4	14.6	1.3	2.9	28.4	17.0	1.4	3.4	33.0
Rowen,	15	17.	5.9	22.2	3.0	10.5	41.4	26.7	3.6	12.7	49.9	14.7	1.4	7.2	26.9	17.6	1.7	8.8	32.4

Timothy,	6	14.	4.2	28.3	1.9	8.5	43.1	32.9	2.2	9.9	50.1	14.7	1.1	4.1	27.2	17.1	1.3	4.8	31.6
Red-top,	4	14.	4.3	28.3	1.4	6.8	45.2	32.9	1.6	7.9	52.6	17.3	0.7	4.1	24.4	20.1	0.8	4.8	32.6
Kentucky blue-grass,	2	14.	7.2	29.7	1.8	7.5	39.8	34.5	2.1	8.7	46.3	-	-	-	-	-	-	-	-
Orchard grass,	4	14.	6.1	30.0	2.5	8.1	39.3	34.9	2.9	9.4	45.7	19.2	1.4	4.9	21.4	22.3	1.6	5.6	25.6
Meadow fescue,	5	14.	7.9	31.7	1.6	5.8	39.0	36.9	1.9	6.7	45.3	-	-	-	-	-	-	-	-
Perennial rye-grass,	4	14.	7.9	25.4	2.1	10.1	40.5	29.5	2.4	11.8	47.1	-	-	-	-	-	-	-	-
Italian rye-grass,	4	14.	6.5	28.6	1.6	7.1	42.2	33.2	1.9	8.4	49.0	-	-	-	-	-	-	-	-
Hungarian grass,	1	14.	4.9	27.5	1.9	8.2	43.5	31.9	2.3	9.5	50.6	18.7	1.2	4.9	29.1	21.7	1.5	5.7	33.9
Barn-yard grass,	1	14.	8.6	29.0	1.7	13.1	33.6	33.7	2.0	15.2	39.1	-	-	-	-	-	-	-	-
Black grass (salt) (*Juncus Gerardi*),	2	16.	7.7	24.4	2.4	6.8	42.7	29.0	2.9	8.1	50.8	14.6	1.0	4.3	23.9	17.4	1.2	5.1	28.4
High-grown salt hay (largely *spartina juncea*).	1	16.	7.0	22.2	2.1	6.3	46.4	26.4	2.5	7.5	55.3	11.1	1.0	4.0	24.6	13.2	1.2	4.7	29.3
Branch grass (salt) (largely *spartina juncea*),	1	16.	8.8	22.3	1.8	7.0	44.1	26.6	2.2	8.3	52.4	11.6	0.6	4.3	23.8	13.8	0.7	5.1	28.3
Low meadow fox grass (salt) (*spartina juncea*).	1	16.	5.4	22.3	2.2	6.0	48.1	26.5	2.6	7.2	57.3	11.4	0.5	3.0	25.0	13.5	0.6	4.1	29.8
Salt hay (variety unknown),	2	16.	4.3	24.0	2.5	3.4	49.8	28.6	3.0	4.0	59.3	-	-	-	-	-	-	-	-
Swamp or swale hay,	2	14.	5.8	26.7	1.9	7.1	44.5	31.0	2.2	8.3	51.8	8.8	0.8	2.4	20.5	10.2	1.0	2.8	23.8
Vetch and oats (1 to 1),	1	14.	8.1	25.8	2.4	14.4	35.3	30.0	2.8	16.7	41.1	-	-	-	-	-	-	-	-
Vetch and oats (1 to 4),	1	14.	7.8	25.8	3.3	11.4	37.7	30.0	3.8	13.3	43.8	17.0	2.6	6.8	20.4	19.8	3.0	8.0	23.7
Vetch and barley,	2	14.	5.3	27.9	2.0	11.9	38.9	32.4	2.3	13.8	45.2	18.4	1.6	7.1	21.0	21.4	1.8	8.3	24.4
Oats in bloom,	1	15.	5.6	30.6	2.4	5.5	40.9	36.0	2.8	6.5	48.1	17.1	1.5	3.9	29.9	20.2	1.7	4.6	35.1
Oats in milk,	1	15.	5.2	29.2	2.3	9.3	39.0	34.4	2.7	10.9	45.9	16.4	1.4	6.5	28.5	19.3	1.7	7.6	33.5
Oats, ripe,	1	15.	5.3	30.9	2.2	5.2	41.4	36.4	2.6	6.1	48.7	-	-	-	-	-	-	-	-
Winter rye in bloom,	1	15.	5.4	28.1	2.2	9.1	40.2	33.0	2.6	10.7	47.3	-	-	-	-	-	-	-	-

A. Composition and Digestibility of Cattle Feeds — Continued.

		Composition.										Digestibility.							
		Fresh or Air-dry Substance.						Water-free Substance.				Fresh or Air-dry Substance.				Water-free Substance.			
Name.	Analyses.	Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
III. (a) Hay and Dry Coarse Fodders — Con.																			
Barley in milk,	1	15.	4.2	24.7	2.4	8.8	44.9	29.0	2.8	10.4	52.8	13.8	1.5	6.2	32.8	16.2	1.7	7.3	38.5
Common millet,	6	15.	4.3	28.3	1.8	6.6	44.0	33.3	2.1	7.8	51.8	-	-	-	-	-	-	-	-
Japanese millet,	3	15.	4.7	30.1	1.8	5.1	43.3	35.4	2.1	6.0	50.9	-	-	-	-	-	-	-	-
III. (b) Legumes.																			
Mammoth red clover,	5	15.	8.1	24.4	1.8	13.1	37.6	28.7	2.1	15.4	44.2	-	-	-	-	-	-	-	-
Medium red clover,	4	15.	7.3	26.0	2.4	11.8	37.5	30.6	2.7	13.9	44.1	12.0	1.3	6.5	24.0	14.1	1.4	7.6	28.2
Alsike clover,	8	15.	9.8	23.1	2.1	14.0	36.0	27.2	2.5	16.5	42.4	12.2	1.1	9.2	25.6	14.4	1.3	10.9	30.1
Lucerne (alfalfa),	6	15.	6.8	26.1	1.6	11.6	38.9	30.7	1.9	13.6	45.8	11.2	0.8	8.0	28.0	13.2	0.9	9.4	33.0
Sand lucerne,	1	15.	8.3	18.0	2.2	13.9	42.6	21.2	2.6	16.4	50.0	-	-	-	-	-	-	-	-
English gray pea,	1	15.	8.2	25.7	2.7	17.5	30.9	30.2	3.2	20.6	36.4	-	-	-	-	-	-	-	-
Canada beauty pea,	1	15.	6.7	24.7	2.3	13.7	37.6	29.0	2.7	16.1	44.3	-	-	-	-	-	-	-	-
Sainfoin,	1	15.	7.3	20.4	3.0	14.8	39.5	24.0	3.5	17.4	46.5	-	-	-	-	-	-	-	-

III. (c) Straw.																			
Wheat straw,	1	15.	4.1	30.5	1.4	6.2	42.8	35.9	1.6	7.3	50.4	15.9	0.4	0.7	16.3	18.7	0.5	0.8	19.2
Barley straw,	2	15.	4.8	32.2	2.5	6.5	39.0	37.9	2.9	7.7	45.9	18.0	1.1	1.3	21.1	21.2	1.2	1.5	24.8
Millet straw,	1	15.	5.8	35.5	1.2	4.2	38.3	41.8	1.4	4.9	45.1	-	-	-	-	-	-	-	-
Straw (*P. crus-galli*),	1	15.	4.6	30.4	2.1	5.2	42.7	35.8	2.5	6.1	50.2	-	-	-	-	-	-	-	-
Straw (*P. miliaceum*),	1	15.	5.2	35.9	2.5	3.3	38.1	42.2	3.0	3.9	44.8	-	-	-	-	-	-	-	-
Straw (*P. Italicum*),	1	15.	5.3	35.2	1.4	3.6	39.5	41.4	1.7	4.2	46.5	-	-	-	-	-	-	-	-
Soy-bean straw,	3	15.	6.1	36.1	1.8	4.7	36.3	42.5	2.1	5.5	42.7	13.7	0.1	2.4	24.0	16.2	1.3	2.8	28.2
Horse-bean straw,	1	15.	8.1	35.2	1.3	8.3	32.1	41.4	1.5	9.8	37.8	13.7	0.7	4.1	20.5	16.1	0.8	4.8	24.2
III. (d) Miscellaneous.																			
Teosinte,	1	15.	6.0	24.5	1.1	8.2	45.2	28.8	1.3	9.6	53.2	-	-	-	-	-	-	-	-
Sulla,	2	15.	7.9	17.6	2.3	14.5	42.7	20.7	2.7	17.1	50.2	-	-	-	-	-	-	-	-
Hairy lotus,	2	15.	7.0	16.8	2.5	12.6	46.1	19.8	3.0	14.8	54.2	-	-	-	-	-	-	-	-
White daisy,	1	15.	6.0	30.7	2.0	6.6	39.7	36.1	2.4	7.8	46.7	14.1	1.2	3.8	26.6	16.6	1.5	4.5	31.3
Carrot tops,	1	15.	11.8	11.6	1.7	18.0	41.9	13.6	2.0	21.2	49.3	-	-	-	-	-	-	-	-
IV. Roots, Tubers, Fruits, etc.																			
Beets, red,	7	88.	1.1	0.7	0.1	1.5	8.6	5.8	0.8	12.5	71.7	0.5	0.1	1.4	8.6	4.3	0.4	11.4	71.7
Beets, sugar,	12	86.	0.8	0.9	0.1	1.5	10.7	6.4	0.7	10.7	76.5	0.7	0.1	1.4	10.7	4.8	0.4	9.7	76.5
Beets, yellow fodder,	4	89.	1.0	1.0	0.2	1.3	7.5	9.1	1.8	11.8	68.2	0.8	0.1	1.2	7.5	6.8	0.9	10.7	68.2
Mangolds,	5	88.	1.2	0.8	0.1	1.4	8.5	6.7	0.8	11.7	70.8	0.6	0.1	1.3	8.5	5.0	0.4	10.6	70.8
Turnips,	5	90.	0.9	1.2	0.2	1.1	6.6	12.0	2.0	11.0	66.0	0.9	0.2	1.0	6.4	9.0	2.0	9.9	64.0

A. *Composition and Digestibility of Cattle Feeds* — Continued.

NAME.	Analyses.	COMPOSITION.										DIGESTIBILITY.							
		FRESH OR AIR-DRY SUBSTANCE.						WATER-FREE SUBSTANCE.				FRESH OR AIR-DRY SUBSTANCE.				WATER-FREE SUBSTANCE.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
IV. Roots, Tubers, Fruits, etc. — Con.																			
Ruta-bagas,	3	89.	1.1	1.3	0.2	1.2	7.2	11.8	1.8	10.9	65.5	1.0	0.2	1.0	6.8	8.8	1.5	8.7	62.2
Carrots,	5	89.	0.9	1.1	0.2	1.0	7.8	10.0	1.8	9.1	70.9	–	–	–	–	–	–	–	–
Parsnips,	1	80.	1.5	1.5	0.7	1.3	15.0	7.5	3.5	6.5	75.0	–	–	–	–	–	–	–	–
Potatoes,	14	81.	1.0	0.5	0.1	1.9	15.5	2.6	0.5	10.0	81.6	–	–	0.8	14.1	–	–	4.4	74.2
Artichokes,	1	78.	1.1	0.9	0.2	2.9	16.9	4.1	0.9	13.1	76.9	–	–	–	–	–	–	–	–
Apples,	2	78.	0.7	1.5	0.5	1.0	18.3	6.8	2.3	4.5	83.2	–	–	–	–	–	–	–	–
Apple pomace,	3	83.	0.4	2.9	0.8	1.2	11.7	17.0	4.7	7.1	68.8	–	–	–	–	–	–	–	–
Sugar-beet pulp,	1	90.	0.1	2.5	0.1	1.4	5.9	25.0	1.0	14.0	59.0	–	–	–	–	–	–	–	–
Cranberries,	1	89.	0.2	1.2	0.6	0.5	8.5	10.9	5.5	4.5	77.3	–	–	–	–	–	–	–	–
Japanese radish (*merinia*),	1	93.	0.7	0.7	0.1	0.5	5.0	10.0	1.4	7.1	71.5	–	–	–	–	–	–	–	–
Japanese radish (*niyas-hige*),	1	93.	0.7	0.7	0.1	0.5	5.0	10.0	1.4	7.1	71.5	–	–	–	–	–	–	–	–
V. Grains, Seeds, etc.																			
Corn kernels,	29	10.6	1.5	1.9	4.8	10.9	70.3	2.1	5.3	12.2	78.8	–	–	–	–	–	–	–	–
Sweet corn kernels,	1	12.0	1.4	2.1	8.4	11.1	65.0	2.4	9.5	12.6	73.9	–	–	–	–	–	–	–	–

Wheat kernels,	3	10.6	1.8	2.2	1.7	12.4	71.3	2.5	1.9	13.9	79.7	-	-	-	-	-	-	-	-
Oat kernels,	3	10.8	3.0	8.5	5.5	13.6	58.6	9.5	6.2	15.3	65.6	1.8	3.9	11.7	43.4	2.0	4.4	13.6	48.5
Broom-corn seed,	1	14.1	2.2	7.1	3.5	9.6	63.5	8.3	4.0	11.2	73.9	-	-	-	-	-	-	-	-
Soy beans,	4	13.0	5.1	5.0	17.2	31.2	28.5	5.7	19.8	35.8	32.8	2.5	14.6	28.1	20.5	2.8	16.8	32.2	23.6
Red adzinki beans,	2	15.9	3.5	3.9	0.7	20.6	55.4	4.7	0.8	24.4	65.9	-	-	-	-	-	-	-	-
Saddle beans,	1	12.4	5.4	4.2	14.5	13.2	50.3	4.8	16.5	15.1	57.4	-	-	-	-	-	-	-	-
Horse beans,	1	10.3	3.9	7.3	0.9	26.9	50.7	8.1	1.0	30.0	56.5	5.3	0.8	23.7	47.2	5.8	0.9	26.4	52.5
Millet seed,	3	13.3	2.6	7.7	3.7	11.4	61.3	8.9	4.3	13.2	70.6	-	-	-	-	-	-	-	-
Barn-yard millet seed (*P. crus-galli*),	1	10.3	3.1	7.7	5.7	12.3	60.9	8.6	6.3	13.7	67.7	-	-	-	-	-	-	-	-
Chestnuts,	1	44.9	1.5	1.4	8.0	7.3	36.9	2.5	14.5	13.3	67.0	-	-	-	-	-	-	-	-
VI. Flour and Meal.																			
Corn meal,	40	13.6	1.4	1.9	3.4	9.6	70.1	2.2	3.9	11.1	81.1	-	3.1	5.8	65.2	-	3.6	6.7	75.4
Corn and cob meal,	37	10.5	1.4	6.7	3.7	9.0	68.7	7.5	4.1	10.0	76.8	3.0	3.0	0.5	60.5	3.4	3.4	5.2	67.5
Cooked feed (oats and corn),	1	5.5	3.8	8.2	5.0	14.0	63.5	8.6	5.0	14.8	67.6	-	-	-	-	-	-	-	-
Ground wheat,	1	11.5	2.0	2.9	2.0	12.1	69.5	3.3	2.2	13.7	78.6	-	-	-	-	-	-	-	-
Ground oats,	2	9.3	3.5	8.5	3.6	11.4	63.7	9.4	4.0	12.6	70.2	1.7	3.0	8.9	48.4	1.9	3.3	9.9	53.4
Ground barley,	5	13.1	2.4	5.7	1.9	11.3	65.6	6.5	2.2	13.0	75.6	2.9	1.7	7.9	64.0	3.3	2.0	9.1	69.6
Broom-corn meal,	1	13.5	2.1	6.9	3.5	9.7	64.3	8.0	4.1	11.2	74.3	-	-	-	-	-	-	-	-
Pea meal,	1	8.8	2.6	17.7	1.6	19.2	50.1	19.4	1.8	21.0	54.9	4.6	0.9	15.9	47.1	5.0	1.0	1.7	51.6
Peanut meal,	1	8.0	4.0	3.5	10.8	49.0	24.7	3.8	11.8	53.3	26.8	0.8	9.6	44.6	22.7	0.9	10.5	48.5	24.7
"Red dog" flour,	1	9.7	1.9	1.4	4.4	22.6	60.0	1.6	4.9	25.0	66.4	-	-	-	-	-	-	-	-

A. *Composition and Digestibility of Cattle Feeds* — Continued.

NAME.	Analyses.	Composition.										Digestibility.							
		Fresh or Air-dry Substance.						Water-free Substance.				Fresh or Air-dry Substance.				Water-free Substance.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
VI. Flour and Meal — Concluded.																			
Bean meal,	1	12.0	1.4	2.1	8.5	11.0	65.0	2.4	9.7	12.5	73.8	1.5	7.3	9.7	60.5	1.7	8.3	11.0	68.6
Soy-bean meal,	1	9.2	5.0	3.9	16.3	34.8	30.8	4.3	18.0	38.3	33.9	2.0	13.9	31.3	22.2	2.9	15.3	54.5	24.4
VII. (a) By-products and Refuse.																			
Cotton-seed meal,	36	8.0	6.9	6.7	10.7	42.0	25.7	7.3	11.6	45.6	27.9	2.1	10.0	37.0	16.4	2.3	10.8	40.1	17.9
Cotton-seed meal (meats and hull),	1	7.8	3.6	19.8	6.7	26.4	35.7	21.4	7.2	28.7	38.8	-	-	-	-	-	-	-	-
Linseed meal, old process,*	9	9.7	6.0	7.6	6.6	33.5	36.6	8.4	7.3	37.1	40.5	4.3	5.9	29.8	28.5	4.8	6.5	33.0	31.6
Cleveland linseed meal,	8	8.3	5.9	8.5	2.9	36.1	38.3	9.3	3.2	39.3	41.8	6.3	2.7	30.7	32.2	6.9	3.0	33.4	35.1
Cleveland flax meal,	1	9.9	5.3	7.6	2.5	40.2	34.5	8.4	2.8	44.6	38.3	-	-	-	-	-	-	-	-
Cocoanut meal,	1	9.3	5.2	17.1	11.7	20.5	36.2	18.8	12.9	22.6	40.0	-	-	-	-	-	-	-	-
VII. (b) Gluten Products.																			
Chicago gluten meal, old process,	3	9.2	0.8	1.1	6.2	30.4	52.3	1.2	6.8	33.5	57.6	-	5.8	27.1	48.6	-	6.3	29.8	53.6
Chicago gluten meal, new process,	6	9.2	1.3	2.5	6.1	37.8	43.1	2.8	6.7	41.5	47.4	-	5.7	33.6	40.1	-	6.2	36.9	44.1

King gluten meal,	3	7.7	1.9	1.4	19.0	35.4	34.6	1.5	20.6	38.4	36.4	–	17.9	32.2	27.3	–	19.4	34.9	28.8
Pope gluten meal (cream),	2	8.0	0.6	1.7	10.2	36.2	43.3	1.8	11.1	39.3	47.1	–	10.0	30.4	38.1	–	10.9	33.0	41.4
Iowa gluten meal (golden),	1	4.8	1.2	6.9	12.9	25.7	48.5	7.2	13.5	27.0	51.0	5.4	10.2	21.3	43.7	5.6	10.7	22.4	45.9
Hammond gluten meal,	1	8.2	1.1	1.5	9.7	29.9	49.6	1.6	10.6	32.6	54.0	–	9.0	26.6	46.1	–	9.9	29.0	50.2
Gluten meal (varieties uncertain),	38	9.0	0.9	3.3	8.3	27.3	51.2	3.6	9.1	30.0	56.3	–	7.6	24.3	45.1	–	8.4	26.7	49.5
Buffalo gluten feed,	18	8.2	0.9	6.8	11.5	23.2	49.4	7.4	12.5	25.2	53.6	5.3	9.1	19.3	44.5	5.8	9.9	20.9	48.2
Buffalo gluten feed,†	1	10.5	2.6	6.7	4.4	27.1	48.7	7.5	4.9	30.3	54.4	5.2	3.3	22.5	43.8	5.8	3.9	25.1	49.0
Peoria gluten feed,	8	6.9	0.6	7.4	11.5	21.4	52.2	8.0	12.4	23.0	56.1	5.8	9.1	17.8	47.0	6.2	9.8	19.1	50.5
Pope gluten feed,	2	8.0	1.3	6.3	8.4	25.3	50.7	6.9	9.1	27.5	55.1	4.9	6.6	21.0	45.6	5.4	7.2	22.8	49.6
Diamond gluten feed,	1	8.4	1.1	7.3	10.2	22.0	51.0	8.0	11.1	24.0	55.7	5.7	8.1	18.3	45.9	6.2	8.8	19.9	50.1
Chicago maize feed,	5	8.2	0.6	7.5	7.1	24.9	51.7	8.2	7.7	27.1	56.3	5.4	6.4	20.9	43.9	5.9	6.9	22.8	47.9
Starch feed (Pope),	1	5.5	0.8	14.5	10.7	10.7	57.8	15.2	11.3	11.3	61.3	–	–	–	–	–	–	–	–
Glucose feed (Richardson),	1	6.3	1.0	11.0	11.0	21.6	49.1	11.7	11.7	23.1	52.4	–	–	–	–	–	–	–	–
Corn germ feed,	1	7.5	0.8	13.0	11.3	10.0	57.4	14.1	12.2	10.8	62.0	–	–	–	–	–	–	–	–
Atlas gluten feed,	9	7.5	1.7	11.0	12.6	31.5	35.7	11.9	13.6	34.1	38.6	11.0	11.5	23.0	30.0	11.9	12.4	24.9	32.4
Corn screenings,	1	11.1	2.1	2.9	4.0	7.4	72.5	3.3	4.5	8.3	81.5	–	–	–	–	–	–	–	–
Dried brewer's grain,	5	9.0	3.8	10.6	4.9	22.8	48.9	11.7	5.4	25.1	53.7	5.6	4.5	18.0	28.9	6.2	4.9	19.8	31.7
Wet brewer's grain,	1	77.0	0.7	3.8	2.0	6.7	9.8	16.7	8.5	29.0	42.5	–	–	–	–	–	–	–	–
Malt sprouts,	2	12.0	5.2	12.8	2.6	24.3	43.1	14.6	3.0	27.6	49.0	4.4	2.6	19.4	29.7	5.0	3.0	22.1	33.8

* National Linseed Oil Company.

† Improved process.

A. *Composition and Digestibility of Cattle Feeds* — Continued.

NAME.	Analyses.	Composition.										Digestibility.							
		Fresh or Air-dry Substance.						Water-free Substance				Fresh or Air-dry Substance				Water-free Substance.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
VII. (c) Brans and Middlings.																			
Cotton-hull bran,	1	11.	1.9	35.0	1.1	2.3	48.7	39.3	1.2	2.6	54.7	-	-	-	-	-	-	-	-
Spring wheat bran,	4	11.	5.7	10.4	5.0	15.9	52.0	11.7	5.6	17.9	58.4	2.5	3.8	12.7	36.4	2.8	4.2	14.3	40.9
Winter wheat bran,	3	11.	6.2	8.5	2.9	15.1	56.3	9.6	3.2	17.0	63.3	2.3	1.9	11.6	36.6	2.6	2.0	13.1	41.1
Wheat bran (average),	53	11.	6.7	9.6	4.5	16.1	52.1	10.8	5.0	18.1	58.5	2.1	3.2	12.6	35.4	2.4	3.6	14.1	39.8
Heavy bran (bran and flour),	2	11.	4.1	7.2	4.5	16.8	56.4	8.1	5.1	18.4	63.4	-	-	-	-	-	-	-	-
Boston mixed feed,	1	11.	4.8	6.3	4.6	19.2	54.1	7.1	5.2	21.6	60.8	-	-	-	-	-	-	-	-
"Imperial mill" mixed feed,	1	11.	3.1	5.1	4.5	15.0	61.3	5.7	5.0	16.9	68.8	-	-	-	-	-	-	-	-
Quincy mixed feed,	1	11.	4.8	6.9	5.1	16.5	55.7	7.8	5.7	18.5	62.6	-	-	-	-	-	-	-	-
Rye bran,	2	11.	4.1	3.5	2.3	15.6	63.5	4.0	2.6	17.8	71.3	-	-	-	-	-	-	-	-
Pea bran,	1	11.	2.9	41.1	1.1	9.2	34.7	46.2	1.2	10.3	39.0	-	-	-	-	-	-	-	-
Louisiana rice bran,	1	11.	9.4	13.3	8.6	8.7	49.0	14.9	9.7	9.8	55.0	-	-	-	-	-	-	-	-
Wheat middlings,	11	11.	5.1	6.6	4.8	15.8	56.7	7.4	5.4	17.8	63.7	23.8	4.1	13.4	49.9	2.7	4.6	15.1	56.1
Rye middlings,	1	11.	3.6	3.3	5.0	11.7	65.4	3.7	5.6	13.2	73.5	-	-	-	-	-	-	-	-

Oat middlings,	1	11.	4.2	17.4	3.3	10.8	53.3	19.5	3.7	12.1	59.9	-	-	-	-	-	-	-	-
Buckwheat middlings,	1	11.	4.8	4.6	6.7	22.7	50.2	5.2	7.5	25.5	56.4	-	-	-	-	-	-	-	-
VII. (d) Miscellaneous.																			
Cotton hulls,	4	11.	2.6	40.2	2.8	5.8	37.6	45.2	3.1	6.5	42.2	18.9	2.2	3.2	12.8	21.2	2.4	3.7	14.3
Cotton-seed feed,	2	10.	3.0	37.6	3.4	10.4	35.6	41.8	3.8	11.6	39.5	-	-	-	-	-	-	-	-
Hominy meal (previous to 1891),	4	8.	2.3	3.9	9.0	9.6	67.2	4.3	9.8	10.4	73.1	-	-	-	-	-	-	-	-
Hominy chop or meal,*	1	7.8	2.9	4.3	9.8	11.8	63.4	4.6	10.6	12.8	68.9	-	-	-	-	-	-	-	-
Cerealine,	2	10.	2.7	5.4	8.9	12.1	60.9	6.0	9.9	13.4	67.7	-	-	-	-	-	-	-	-
Rice meal,	2	10.2	8.1	5.4	13.1	12.0	51.2	6.0	14.6	13.2	57.0	-	11.9	7.4	47.1	-	13.3	8.2	52.4
Excelsior feed,	1	7.1	4.1	13.7	5.0	9.1	61.0	14.7	5.4	9.8	65.7	-	-	-	-	-	-	-	-
Oat feed,	20	7.5	5.0	15.1	4.0	11.1	57.3	16.3	4.3	12.0	61.9	-	-	-	-	-	-	-	-
Proteina,	4	8.4	2.5	10.0	6.6	21.7	50.8	10.9	7.2	23.7	55.5	-	-	-	-	-	-	-	-
Hall's dairy feed,	1	7.2	6.1	10.2	9.5	20.8	46.2	11.0	10.2	22.4	49.8	-	-	-	-	-	-	-	-
Rye feed,	2	8.9	2.7	3.3	2.6	13.8	68.7	3.6	2.9	15.1	75.4	-	-	-	-	-	-	-	-
Peanut feed,	2	10.0	2.6	56.4	5.5	8.9	16.6	62.7	6.1	9.9	18.4	6.8	5.0	6.3	8.1	7.5	5.5	7.0	9.0
Peanut husks,	1	13.0	1.2	66.0	1.7	5.0	13.1	75.9	1.9	5.7	15.1	-	-	-	-	-	-	-	-
Bakery refuse,	1	13.3	10.1	0.3	5.5	8.0	62.8	0.4	6.4	9.2	72.4	-	-	-	-	-	-	-	-
Vinegar mash,	1	94.5	0.2	0.5	0.5	0.9	3.4	8.6	8.5	16.5	63.4	-	-	-	-	-	-	-	-
Refuse from starch works,	1	57.0	0.4	3.2	4.4	9.6	25.4	7.5	10.2	22.4	59.0	-	-	-	-	-	-	-	-
Glucose refuse,	1	6.7	1.1	4.5	9.9	19.7	58.1	4.8	10.6	21.1	62.3	-	-	-	-	-	-	-	-

* Recent analysis.

A. *Composition and Digestibility of Cattle Feeds* — Concluded.

NAME.	Analyses.	Composition.										Digestibility.							
		Fresh or Air-dry Substance.						Water-free Substance.				Fresh or Air-dry Substance.				Water-free Substance.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
VII. (d) Miscellaneous — Concluded.																			
Damaged wheat,	1	18.1	2.0	2.7	2.2	14.2	65.8	3.1	2.5	16.3	75.8	-	-	-	-	-	-	-	-
Cocoa dust,	1	7.1	6.3	5.5	24.1	14.4	42.6	5.9	25.9	15.5	45.9	-	-	-	-	-	-	-	-
Broom-corn waste,	1	8.7	4.5	35.9	0.9	6.1	43.9	39.3	1.0	6.8	48.0	-	-	-	-	-	-	-	-
Sugar-beet refuse,	1	28.9	5.3	5.8	0.3	8.6	51.1	8.1	0.4	12.1	71.9	-	-	-	-	-	-	-	-
Corn cobs,	6	7.6	1.3	31.4	0.5	2.7	56.5	34.0	0.6	2.9	61.1	20.4	0.3	0.5	33.9	22.1	0.3	0.5	36.7
Palmetto root,	1	11.5	3.9	18.9	0.4	3.4	61.9	21.3	0.5	3.8	70.0	-	-	-	-	-	-	-	-
Ground cloves,	2	12.2	7.4	28.1	2.0	13.2	37.1	32.0	2.3	15.0	42.3	-	-	-	-	-	-	-	-
Calf meal (Blatchford),	1	8.1	4.3	4.6	4.5	25.6	52.9	5.0	4.9	27.8	57.6	-	-	-	-	-	-	-	-
Animal meal (Bowker's),	1	5.1	28.6	-	16.2	40.0	-	-	17.1	42.2	-	-	-	-	-	-	-	-	-

B. Fertilizing Ingredients in Fodder Articles.

[Figures equal percentages or pounds in 100.]

NAME.	Analyses.	Water.	Nitrogen.	Potassium Oxide.	Phosphoric Acid.	Valuation per 2,000 Pounds.*
I. Green Fodders.						
Corn fodder,	14	79.	.41	.33	.15	$1 45
Sorghum,	7	83.	.23	.23	.09	86
Barn-yard millet (*Panicum crus-galli*),	1	75.	.46	.49	.11	1 69
Japanese millet (*P. Italicum*),	3	63.	.61	.41	.19	2 05
Summer rape,	1	86.	.32	.73	.09	1 60
Green oats,	3	83.	.49	.38	.13	1 67
Green rye,	2	72.	.30	.64	.12	1 47
Hungarian grass,	1	74.	.39	.54	.16	1 62
Vetch and oats,	1	86.	.24	.79	.09	1 45
Horse bean,	1	75.	.68	.35	.08	2 05
Flat pea,	1	79.	1.05	.45	.14	3 10
Cow pea,	1	82.	.32	.18	.10	1 04
Small pea,	1	82.	.48	.37	.11	1 62
Soy bean,	1	73.	.29	.53	.15	1 36
Soy bean (early white),	1	67.	.94	.91	.21	3 36
Soy bean (medium green),	1	70.	.84	.71	.20	2 91
Soy bean (medium black),	1	77.	.80	.57	.18	2 65
Soy bean (late),	1	80.	.60	.68	.14	2 25
Bokhara or sweet clover,	1	79.	.45	.42	.13	1 62
Serradella,	2	83.	.41	.42	.14	1 53
Spring vetch,	1	85.	.36	.45	.10	1 40
Kidney vetch,	1	81.	.56	.35	.09	1 78
Prickly comfrey,	1	87.	.37	.76	.12	1 76
Common buckwheat,	1	85.	.44	.54	.09	1 67
Silver-hull buckwheat,	1	85.	.29	.39	.14	1 21
Japanese buckwheat,	1	85.	.26	.53	.14	1 08
Corn ensilage,	7	80.	.42	.39	.13	1 52
Corn and soy-bean ensilage,	1	71.	.79	.44	.42	2 51
Millet ensilage,	3	74.	.26	.62	.14	1 37
Millet and soy-bean ensilage,	5	76.	.48	.50	.12	1 76
II. Hay and Dry Coarse Fodders.						
Corn fodder,	7	20.	1.53	.77	.47	4 87
Corn stover,	17	20.	.92	1.22	.26	3 66

* Using the figures for the retail cost of nitrogen, phosphoric acid and potash in fertilizers, the amounts obtained show comparative rather than actual values, because the ingredients in fertilizers are easier to handle and in a more available form than in fodders.

B. Fertilizing Ingredients in Fodder Articles — Continued.

NAME.	Analyses.	Water.	Nitrogen.	Potassium Oxide.	Phosphoric Acid.	Valuation per 2,000 Pounds.*
II. Hay and Dry Coarse Fodders — Con.						
English hay,	12	15.	1.27	1.50	.29	$4 81
Rowen,	13	15.	1.70	1.56	.46	6 05
Timothy,	3	15.	1.19	1.40	.33	4 55
Red top,	4	15.	1.06	.94	.33	3 78
Kentucky blue-grass,	2	15.	1.19	1.52	.39	4 73
Orchard grass,	4	15.	1.22	1.58	.38	4 85
Meadow fescue,	6	15.	.92	1.96	.37	4 50
Perennial rye-grass,	2	15.	1.15	1.45	.52	4 68
Italian rye-grass,	4	15.	1.11	1.18	.52	4 32
Salt hay,	1	15.	1.06	.65	.23	3 40
Millet,	1	15.	1.22	1.61	.46	4 95
Vetch and oats,	3	15.	1.23	1.27	.62	4 78
Mammoth red clover,	3	15.	2.14	1.16	.52	6 76
Medium red clover,	2	15.	2.01	2.11	.41	7 30
Alsike clover,	6	15.	2.26	2.10	.63	8 09
Lucerne (alfalfa),	4	15.	1.87	1.32	.48	6 04
Sainfoin,	1	15.	2.54	1.95	.73	8 69
Barley straw,	2	15.	.95	2.03	.19	4 48
Soy-bean straw,	1	15.	.69	1.04	.25	2 92
Millet straw,	1	15.	.68	1.73	.18	3 52
Teosinte,	1	15.	1.32	3.35	.16	6 66
White lupine,	1	15.	2.56	1.46	.29	7 87
Yellow lupine,	1	15.	2.28	2.51	.51	12 57
Spanish moss,	1	15.	.61	.56	.07	2 09
Sulla,	2	15.	2.31	1.96	.42	7 88
White daisy,	1	15.	.26	1.18	.41	2 17
Carrot tops,	1	15.	2.95	4.60	.57	12 19
III. Roots, Tubers, Fruits, etc.						
Beets, red,	8	88.	.24	.44	.09	1 10
Beets, sugar,	4	87.	.22	.48	.10	1 10
Beets, yellow fodder,	1	91.	.19	.46	.09	99
Mangolds,	3	88.	.15	.34	.14	83
Turnips,	4	90.	.17	.38	.12	90
Ruta-bagas,	3	89.	.19	.49	.12	1 03

* See note on page 251.

B. Fertilizing Ingredients in Fodder Articles — Continued.

NAME.	Analyses.	Water.	Nitrogen.	Potassium Oxide.	Phosphoric Acid.	Valuation per 2,000 Pounds.*
III. Roots, Tubers, Fruits, etc. — Con.						
Carrots,	3	89.	.16	.46	.09	$0 93
Parsnips,	1	80.	.22	.62	.19	1 32
Potatoes,	4	80.	.29	.51	.08	1 29
Artichokes,	1	78.	.46	.48	.17	1 74
Apples,	2	80.	.13	.19	.01	51
Apple pomace,	2	81.	.23	.13	.02	70
Cranberries,	1	89.	.08	.10	.03	32
Japanese radish (*merinia*),	1	93.	.08	.28	.05	52
Japanese radish (*niyas hige*),	1	93.	.08	.34	.05	58
IV. Grains, Seeds, etc.						
Corn kernels,	13	10.9	1.82	.40	.70	5 04
Oat kernels,	1	9.0	2.10	–	–	–
Soy bean,	2	18.3	5.30	1.99	1.87	16 39
Red adzinki beans,	1	14.8	3.24	1.54	.94	10 16
White adzinki beans,	1	16.9	3.33	1.48	.97	10 35
Saddle beans,	1	12.3	2.12	2.13	1.52	8 59
Common millet,	2	11.5	2.01	.45	.96	6 02
Japanese millet,	1	13.7	1.73	.38	.69	5 15
Chestnuts,	1	45.0	1.18	.63	.39	3 79
V. Flour and Meal.						
Corn meal,	3	14.1	1.92	.34	.71	5 59
Corn and cob meal,	29	9.0	1.41	.47	.57	4 37
Wheat flour,	2	12.1	2.02	.36	.35	5 52
Ground barley,	1	13.4	1.55	.34	.66	4 65
Pea meal,	1	8.9	3.08	.99	.82	9 12
Soy-bean meal,	1	10.8	5.89	2.23	1.57	17 80
Peanut meal,	1	8.0	7.84	1.54	1.27	21 50
VI. By-products and Refuse.						
Cotton-seed meal,	24	8.2	6.70	1.83	2.47	20 13
Linseed meal (old process),	4	8.0	5.39	1.21	1.78	15 75
Cleveland linseed meal,	5	8.0	5.83	1.25	1.70	16 76
Gluten meal (Chicago),	2	9.6	6.04	.06	.43	14 74
Gluten meal (King),	1	7.8	5.69	.08	.69	14 36
Gluten meal (variety uncertain),	5	8.5	5.09	.05	.42	12 64

* See note on page 251.

B. Fertilizing Ingredients in Fodder Articles — Concluded.

NAME.	Analyses.	Water.	Nitrogen.	Potassium Oxide.	Phosphoric Acid.	Valuation per 2,000 Pounds.*
VI. By-products and Refuse — Con.						
Gluten feed (Buffalo),	5	8.2	3.72	.06	.34	$9 29
Atlas gluten feed,	1	11.2	4.80	.16	.23	11 89
Dried brewers' grain,	2	8.6	3.65	.85	1.05	10 76
Wheat bran,	10	9.9	2.36	1.40	2.10	8 95
Louisiana rice bran,	1	10.3	1.43	.84	1.71	5 81
Wheat middlings,	2	10.2	2.75	.75	1.25	8 48
Rye middlings,	1	12.5	1.84	.81	1.26	6 36
Buckwheat hulls,	1	11.9	.49	.52	.07	1 76
Cotton hulls,	3	10.6	.75	1.08	.18	3 05
Proteina,	1	10.1	2.97	.57	1.00	8 59
Rye feed,	1	9.6	1.95	.98	1.56	7 06
Peanut feed,	2	10.0	1.46	.79	.23	4 50
Peanut husks,	1	13.0	.80	.48	.13	2 52
Damaged wheat,	1	13.1	2.26	.51	.83	6 68
Glucose refuse,	1	6.7	3.37	.09	.61	8 73
Cocoa dust,	1	7.1	2.30	.63	1.34	7 36
Broom corn waste (stalks),	1	10.4	.87	1.86	.46	4 36
Corn cobs,	8	12.1	.50	.60	.06	1 85
Palmetto roots,	1	11.5	.54	1.38	.16	2 82
Meat meal,	1	8.0	11.21	.30	.73	27 86
VII. Dairy Products.						
Buttermilk,	1	91.1	.51	.05	.04	1 31
Skim-milk,	22	90.3	.59	–	–	–
Whey,	1	93.7	.10	.07	.17	47

* See note on page 251.

C. Analyses of Dairy Products (Per Cent.).

	Analyses.	Solids.			Fat.			Curd.	Salt.	Ash.
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.			
Whole milk,	2,173	18.27	10.20	13.52	7.54	1.72	4.20	3.51 [1]	-	.71 [2]
Skim-milk,	354	10.48	7.68	9.48	1.02	.05	.32	-	-	-
Buttermilk,	31	9.86	6.83	8.33	.38	.11	.27	-	-	-
Cream (from Cooley process),	203	32.78	18.12	26.10	25.00	10.53	17.60	-	-	.62
Cream (concentrated commercial),	2	50.12	48.71	49.41	45.63	32.20	42.33 [3]	-	-	-
Butter (salted),	39	92.89	85.35	89.21	89.05	81.43	84.36	1.17	3.43	-
Butter (fresh),	14	85.36	72.49	82.24	85.05	72.21	81.48	.76	-	-
Whole-milk cheese (Jersey),*	1	-	-	62.84	-	-	37.32	22.13	-	3.39
Whole-milk cheese,*	1	-	-	64.17	-	-	34.34	26.69	-	3.14
Cheese from milk skimmed after twelve hours' standing,*	1	-	-	62.70	-	-	27.81	30.37	-	4.52
Cheese from milk skimmed after twenty-four hours' standing,*	1	-	-	57.76	-	-	23.42	31.99	-	2.35
Cheese from milk skimmed after thirty-six hours' standing,*	1	-	-	56.05	-	-	17.67	33.24	-	5.14
Cheese from milk skimmed after forty-eight hours' standing,*	1	-	-	54.59	-	-	15.77	34.94	-	3.88
Cheese from skim-milk, with addition of buttermilk,*	1	-	-	51.62	-	-	18.35	28.63	-	4.64
Genuine oleomargarine cheese,*	1	-	-	62.10	-	-	31.66	25.94	-	4.50

* From analyses made in 1875: [1] Average of 42 determinations; [2] Average of 8 determinations; [3] Average of 5 determinations.

Tables of the Digestibility of American Feed Stuffs.

Experiments made in the United States.

Compiled by J. B. LINDSEY.

I. Experiments with Ruminants.

II. Experiments with Swine.

Dec. 31, 1896.

TABLES OF THE DIGESTIBILITY OF AMERICAN FEED STUFFS.

I. Experiments with Ruminants.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay and Dry Coarse Fodders.								
Timothy hay (in bloom),	3	5	55.6—65.7 60	56.4—66.8 60	55.8—62.1 58	51.5—61.8 57	50.3—60.4 56	57.5—71.8 63
Timothy hay (past bloom),	5	10	47.0—61.1 53	48.4—62.3 54	37.2—56.8 47	34.6—61.1 53	38.8—50.4 45	55.6—66.9 60
Timothy hay (average all trials),	12	26	57	58	52	60	48	63
Hay of mixed grasses (medium in protein*),	1	2	-	-	49	50	40	58
Hay of mixed grasses (rich in protein),	6	20	54—62 58	- -	56—66 60	44—57 48	56—64 58	56—63 59
Rowen (mixed grasses),	1	4	- -	63—67 65	65—68 66	44—50 46	68—70 69	63—68 65
Rowen (chiefly timothy),	1	4	- -	62—67 64	62—73 66	48—51 49	66—69 68	60—65 63
Average (both samples),	-	-	-	65	66	47	68	64
Salt hay of black grass (*Juncus Gerardi*),	1	2	57—62 60	- -	57—64 60	37—46 41	62—63 63	53—59 56
High-grown salt hay (largely *Spartina juncea*),	1	2	51—55 53	- -	46—55 50	42—51 47	62—63 63	52—55 53
Branch grass (*Spartina juncea*, with *Spartina stricta*, var. *glabra*),	1	2	55—57 56	- -	48—56 52	27—36 31	61—63 62	54—55 54
Low meadow fox grass (*Spartina juncea*),	1	2	52—54 53	- -	49—53 51	17—30 24	- 57	51—52 52

Meadow, swale or swamp hay,	1	2	38—40 39	- -	30—36 33	- 44	31—37 34	- 46
Hay of vetch and oats,	1	2	58—58 58	- -	65—67 66	17—20 19	60—61 60	54—54 54
Clover and timothy hay (poorly cured),	1	2	54.3—55.3 55	- -	52—54.4 53	- 58	37.5—37.9 38	- 60
Hungarian hay,	1	2	64.3—65.8 65	65.9—66.8 66	66.8—68.5 68	- 64	- 60	66.9—67.4 67
Hay of blue-joint grass (past bloom) (*Calamagrostis Canadensis*),	1	1	40	42	37	37	57	43
Hay of blue-joint grass (bloom),	1	2	66.7—70.5 69	68.1—71.5 70	71.5—73.4 72	51.4—53.3 52	68.2—72.3 70	66.4—70.9 69
Hay of orchard grass (ten days after bloom),	1	1	54	56	58	54	59	54
Hay of orchard grass (stage not given),	1	2	57.5—60 59	- -	60—66.7 64	55.4—57.4 56	60—60.8 60	55.3—57.3 56
Average of both samples,	2	3	56	56	61	55	60	55
Hay of red top,	2	3	57.6—62.3 60	59.3—63.6 61	60.8—61.8 61	44.2—58.8 51	60.4—62.4 61	59.1—65.2 62
Dried pasture grass,	1	1	71	-	77	60	72	73
Oat straw,	1	2	49—51.7 50	50.8—53.2 52	57.2—58 58	35.5—41 38	- -	51.8—54.6 53
Barley hay,	1	4	59	62	62	41	65	63
Hay of Legumes.								
Soy-bean hay,	1	2	61.9—62.7 62	- -	59.5—62.1 61	18.7—39.7 29	70.1—72.1 71	66.1—71.5 69
Peanut-vine hay,	1	2	59.5—60.2 60	- -	51.2—52.6 52	62.1—69.8 66	63—63.6 63	69.3—69.7 70

* Below 10 per cent.

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay of Legumes — Concluded.								
Cow-pea-vine hay (fair quality),	1	2	- 59	- -	41.2—44.6 43	46.4—53.7 50	63.9—65.1 65	- 71
Clover hay (late bloom, fair quality),	1	2	54.4—55.5 55	55.9—56.4 56	43.8—49 46	51.8—54.8 53	49.3—59.1 55	63.3—64.8 64
Clover hay (good quality),	1	2	50.8—53.5 52	51.6—54.3 53	46.6—49 48	40—48 43	47—52.2 49	56.8—58.9 58
White clover hay (bloom),	1	1	66	67	61	51	73	70
Scarlet clover hay (*T. incarnatum*),	3	9	56.8—65.4 62	52—58 56	32—58.1 45	29—54 44	64—73 69	52—73.6 62
Alsike clover (*T. hybridum*),	2	3	61.1—64.3 62	62—65.2 63	51—58.7 53	35.1—69.3 50	64—69.2 66	66.5—74.1 71
Alfalfa (lucerne) (late bloom),	1	2		-	49	54	77	64
Alfalfa (lucerne) (stage not given),	1	1	-	-	43	48	69	72
Corn Plant (partially Air Dry).								
Corn stover,	1	4	61.1—62 62	- -	64.8—68.3 67	48.1—55.8 52	49.6—54.8 52	62.5—64.5 64
Corn stover (shredded, fed dry),	1	2	57	-	65	72	38—42 40	56
Corn stover (shredded, fed wet),	1	2	59—62 60	- -	69—70 70	73—76 74	33—39 36	57—61 59

Corn stover (average all tests),	3	8	60	-	67	62	45	61
Corn stover (tops and blades),	1	2	59—60.5 60	- -	71.1—71.7 71	70.6—71.9 71	54.2—56.6 55	61.9—62.6 62
Corn stover (leaves of),	1	2	54.8—56.2 56	- -	54.3—67 61	60.6—65.4 63	43.1—68.8 56	57.1—60.6 59
Corn stalk (below ear),	1	2	64—69 67	- -	71—75 74	79—80 80	15—27 21	65—73 69
Topped stover (part above ear),	1	2	52—58 55	- -	69—72 71	62—65 64	17—27 22	50—57 54
Corn husks,	1	2	71—73 72	- -	78—81 80	23—42 33	24—35 30	75 -
Corn leaves (below ear),	1	2	62—67 65	- -	75—80 78	52—59 56	28—41 35	66—70 68
Flint corn fodder (ears just forming),	1	3	69—72 70	71—73 71	72—73 72	63—71 67	69—73 70	71—73 71
Flint (mature) field corn fodder,	4	9	68—73 71	71—75 73	69—80 76	59—77 70	59—79 65	69—78 73
Dent (mature) field corn fodder,	6	14	57—70 66	- -	43—68 57	64—82 76	30—61 48	61—81 72
Average both kinds,	-	-	68	-	65	74	55	73
Dent (in milk) field corn fodder,	5	11	58.8—66 63	- -	50—71 64	67—79 75	44—51 50	61—69 66
Dent (immature, Burrill and Whitman, coarse),	1	4	51—64 57	- -	45—74 59	66—84 76	20—36 27	57—66 61
Dent (immature, no ears formed),	4	8	61—70 65	63—71 67	63—77 71	59—72 66	57—67 62	57—70 64
Sweet corn fodder (mature),	3	6	60—71 67	62—74 70	70—77 74	63—71 74	54—73 64	57—73 68

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Miscellaneous Dry Substances.								
Hay of wild oat grass (*Danthonica spicata*),	2	3	59.6—68.3 64	61.2—69.1 65	65.1—70.6 68	38.2—62.8 50	48.6—68 58	62.1—68.8 65
Hay of witch grass (*Triticum repens*),	2	4	59.9—62.7 61	61—64.3 62	56.4—67.6 62	53.6—60 57	49.5—64.2 58	62.1—69.9 66
Hay of buttercups (*Ranunculus acris*),	1	2	56	57	41	70	56	67
Hay of white weed (*Leucanthemum vulgare*),	1	2	58	58	46	62	58	67
Cats-tail millet (*Pennesetum spicatum*),	1	2	61.1—63.6 62	– –	64.7—68.4 67	44.7—47.6 46	60.6—64.6 63	58.3—60 59
Johnson-grass hay,	1	1	55	–	58	39	45	54
Sorghum fodder (leaves),	1	2	59.9—66.3 63	– –	64.9—75.9 70	46.3—47.1 47	59.5—62.2 61	62.5—66.6 65
Sorghum bagasse,	1	1	61	–	64	46	14	65
Cotton-seed hulls (fed alone),	4	13	35—47.5 41	– –	.54—57.6 47	58.2—89.3 79	.00—24.6 6	12.9—45.7 34
Cotton-seed hulls when fed with cotton-seed meal (7 to 1 and 6 to 1),	1	3	41 –	– –	33—40 38	– 78	– –	48—50 49
Cotton-seed hulls when fed with cotton-seed meal (4 to 1 to 1½ to 1),	3	11	43—48 45	– –	43—50 46	66—80 76	– –	49—57 51
Cotton-seed feed (hulls and meal, 7 to 1 and 6 to 1),	1	3	45—46 46	– –	34—40 37	81—82 82	44—46 45	50—51 50
Cotton-seed feed (hulls and meal, 4 to 1 to 1½ to 1),	3	11	52—56 55	– –	43—49 46	84—86 85	61—65 62	49—56 54

Green Fodders.								
Dent corn fodder (immature),	4	11	64—74 68	- -	60—76 67	37—83 68	56—80 66	64—79 71
Dent corn fodder (in milk),	3	9	70	-	64	78	61	76
Dent corn fodder (glazing),	5	9	67	-	51	78	54	75
Dent corn fodder (mature),	2	4	65	-	55	73	51	72
Average (glazing and mature),	7	13	66	-	52	76	53	74
Dent corn fodder (ears glazing, Burrill and Whitman, coarse),	1	2	51—54 52	- -	46—47 46	74—82 78	20—28 24	57—61 59
Sweet corn fodder (milk),	1	2	77—78 77	- -	74—76 75	73—74 74	77—78 77	80—81 81
Sweet corn fodder (ears roasting stage), (Storrs),	3	6	- -	67—79 72	54—72 60	76—82 79	52—69 62	73—82 77
Early amber sorghum (just after blossom)	1	2	60.9—61.7 61	- -	41.7—45.3 42	67 -	37.7—42.5 40	70.4—70.8 71
Sorghum in blossom (variety not stated),	1	2	73.1—73.3 73	- -	74—75 75	81.3—81.6 81	51.1—55.7 53	78.2—78 78
Average both samples,	2	4	67	-	59	74	46	74
Green grass (young),	1	1	69	-	74	55	65	72
Same (dry),	1	1	71	-	77	60	71	73
Pasture grass,	1	2	71.9—75.6 74	- -	74.6—76.5 76	74—74.9 74	74—76.5 75	73.8—77.1 75
Average of three samples,	-	-	71	-	76	63	70	73
Rowen grass (mostly Timothy two-thirds grown),	1	2	- -	65—67 66	60—68 64	51—55 52	72—72 72	67—68 68
Barley fodder (bloom),	2	4	- -	62—71 67	49—66 61	56—63 60	69—73 72	69—76 71

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Green Fodders — Concluded.								
Oat fodder (bloom?),	1	2	- -	63—65 64	58—63 60	68—71 70	75—76 75	63—63 63
Rye fodder (formation of head),	1	2	73—74 74	- -	80—80 80	74—74 74	79—80 79	70—71 71
Hungarian grass (early to late bloom),	3	8	61—67 63	61—74 68	65—76 70	48—85 62	59—72 63	64—71 67
Peas and barley (full bloom),	1	2	- -	55—65 60	38—49 43	54—65 60	73—81 77	56—67 61
Peas and oats (bloom?),	1	2	- -	67—69 68	54—61 57	73—74 74	81—82 81	66—67 66
Clover fodder (late blossom),	1	2	65—67 66	- -	52—53 53	63—66 65	66—68 67	76—79 78
Clover rowen (mostly clover late bloom),	1	2	- -	60—62 61	51—54 52	60—61 61	61—62 62	64—68 65
Scarlet clover (late bloom),	1	3	- -	68—70 69	54—58 56	63—69 66	77—77 77	74—75 74
Average three samples,	3	7	-	-	54	64	70	72
Soy-bean fodder (before bloom, August),	1	2	- -	64—67 66	45—55 50	50—58 54	77—80 79	71—73 72
Soy-bean fodder (seed half grown),	1	2	- -	61—63 62	38—43 41	49—59 54	68—71 69	72—75 73
Cow-pea fodder (ready for soiling),	1	2	- -	76—76 76	57—58 57	56—62 59	73—75 74	84—84 84
Canada peas (just before bloom),	1	2	- -	71—72 71	62—62 62	50—55 52	81—83 82	71—71 71

Corn Silage.								
Dent silage (immature),	5	13	60—68 64	- -	71—78 70	64—85 71	42—65 54	60—70 66
Dent silage (milk to mature),	6	17	60—74 64	- -	45—80 62	78—90 85	45—63 52	63—73 69
Dent silage (stage uncertain, North Carolina),	1	4	53—67 60	- -	43—64 56	55—79 70	19—34 24	61—76 68
Flint silage (ears glazing),	4	11	68—78 75	66—80 77	75—79 77	- 82	48—73 65	71—83 79
Fine crushed silage (steers),	1	2	60.4—68 64	- -	72—78 75	75—77 76	32—44 38	60—70 65
Fine crushed silage (sheep),	1	2	51.5—56 54	- -	59.5—67.7 64	67.5—69 68	21—22 21.5	52.6—57.[illegible] 55
Corn silage (raw, ears mature),	1	1	-	-	59	86	45	71
Same (cooked),	1	1	-	-	70	87	39	75
Sweet corn ensilage (occasional ears mature),	1	2	66.6—69.6 68	68.5—71.7 70	68.4—73.7 71	82.3—84.6 83	52.7—55.2 54	70.7—73 72
Soy-bean ensilage (goats),	1	2	52—66 59	- -	47—62 55	66—77 72	71—80 76	46—58 52
Soy-bean ensilage (steers),*	1	2	50—50 50	- -	42—44 43	47—52 49	54—56 55	61—61 61
Cow-pea ensilage (steers),	1	4	59—60 60	- -	50—54 52	62—64 63	57—58 57	72—73 72
Barn-yard millet and soy-bean ensilage (sheep),†	1	4	54—65 59	- -	61—73 69	69—75 72	55—62 57	54—63 59
Corn and soy-bean ensilage (sheep),†	1	3	66—72 69	- -	59—73 65	80—84 82	63—67 65	73—78 75

* Must have been very mature as results are exceptionally low. See green soy bean.

† Millet was *P. crus-galli* (Japan). Corn was Pride of the North (medium dent). Soy bean was medium green.

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Roots, Tubers, etc.								
Potatoes,	1	3	73.3—80.1 77	74.6—81.2 78	- -	13 -	43.4—45.4 44	87.3—93.4 91
Sugar beets,	1	2	94.2—94.8 95	97.6—99.9 99	88.5—113 100	46.4—53.5 50	90—92.6 91	99.8—100 100
Mangolds,	1	2	77.1—80 79	82.7—87 85	26.8—58.8 43	- -	69.7—79.8 75	90.8—91.9 91
English flat turnips,	1	2	90.7—94.9 93	93.2—99 96	89.2—117 100	82.5—92.5 98	84.5—95 90	96—97 97
Ruta-bagas,	1	2	84.4—90 87	89.2—93 91	61—87.5 74	76.8—91.6 84.2	74.7—85.9 80.3	94.4—95.1 95
Grains and Seeds.								
Corn meal (maize),	2	5	83—98 88	- -	- -	80—98 92	40—77 60	85—100 93
Corn and cob meal,	1	3	74—83 79	- -	2—86 45	82—85 84	43—65 52	86—91 88
Pea meal,	1	2	85—88 87	86—89 88	25—26 26	52—57 55	80—86 83	93—94 94
Raw cotton seed,	1	2	63—69 66	- -	65—86 76	- 87	66—70 68	49—50 50
Roasted cotton seed,	1	2	53—58 56	- -	62—69 66	68—75 72	44—50 47	50—53 51
Soy-bean meal,	2	10	75—82 79*	- 78	- -	81—90 85	- 87	- 73
Cotton seed meal,	2	6	67—82 76	- -	32 -	87—100 93	83—96 88	44—75 64

By-products.								
Cleveland linseed meal,	1	3	73—83 80	– –	49—100 74	90—98 93	86—88 85	82—87 84
Old-process linseed meal (National Linseed Oil Company),	1	3	75—82 79	– –	38—71 57	85—92 89	86—93 89	76—79 78
Gluten meal,	1	2	85—90 87	86—92 89	– 33	86—90 88	83—90 87	88—94 91
Chicago gluten meal,	1	2	87—89 88	– –	– –	92—94 93	87—91 89	93—94 93
King gluten meal,	1	2	79—82 81	– –	– –	91—97 94	– 91	78—81 79
Pope cream gluten meal,	1	2	92—95 93	– –	– –	96—99 98	83—84 84	85—91 88
Average all gluten meals,	4	8	87	–	–	93	88	88
Buffalo gluten feed (one lot),	1	2	76—80 78	– –	40—46 43	81—82 81	84—86 85	78—84 81
Buffalo gluten feed (another lot),	1	2	87—88 87	– –	84—94 89	92—95 93	87—87 87	87—87 87
Peoria gluten feed,	1	2	84—87 86	– –	59—97 78	76—82 79	81—85 83	90—90 90
Pope gluten feed,	1	2	86—87 87	– –	76—78 77	79—82 81	85—88 86	90—90 90
Average all gluten feeds,	4	8	84	–	72	83	85	87
Chicago maize feed,	1	2	83—85 84	– –	68—76 72	90—90 90	83—84 84	84—87 85
Atlas gluten meal (feed),	1	2	80—80 80	– –	?– ?–	90—92 91	73—73 73	84—85 84
Winter wheat bran,	1	3	57—66 62	– –	– 27	51—80 64	75—79 77	62—76 65

* For two sheep only.

Table of the Digestibility of American Feed Stuffs — Concluded.

KIND OF FODDER.	Number of Different Samples	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
By-products — Concluded.								
Spring wheat bran,	1	2	62—63 63	– –	22—25 24	76—76 76	78—82 80	70—71 70
Average all wheat bran,	5	11	61	63	22	68	79	69
Wheat middlings,*	1	2	72.6—72.2 75	75.1—79.3 77	– –	84.1—86.1 85	78.4—79.4 79	80.7—84.5 83
Wheat middlings,*	1	2	79.48—85.63 83	– –	32.57—40.06 36	81.71—87.98 85	81.83—87.75 85	84.43—91.08 88
Rice meal,	1	2	71—76 74	– –	? ?	91—92 91	– 62	89—95 92
Rye meal,	1	2	85—90 87	– –	– –	63—65 64	83—85 84	89—94 92
Peanut feed,	1	2	32—32 32	– –	10—13 12	89—90 90	70—71 71	41—58 49
Malt sprouts,	1	1	67	68	34	100	80	69
Dried brewers' grains,	1	2	62—62 62	– –	50—55 53	89—93 91	78—81 79	59—59 59
Corn cobs,	1	2	59—60 59	– –	65—66 65	44—56 50	13—22 17	60—60 60

II. Experiments with Swine.

Maize kernels (whole),	1	1	83	83	38	46	69	89
Maize meal,	2	2	89.5—89.7 90	91.3—92.1 92	29.4—48.7 39	77.6—81.7 80	86.1—89.9 88	93.9—94.2 94
Maize meal (with cobs),	1	1	76	77	29	82	76	84
Pea meal,	1	1	90	92	78	50	89	95
Barley meal,	1*	1	80	80	49	57	81	87
Wheat (whole),	1	?	72	–	30	60	70	74
Wheat (cracked),	1	?	82	–	60	70	80	83
Wheat shorts,	1	2	74—79 77	– –	25—48 37	– –	71—75 73	85.5—88 87
Wheat bran,	1	2	53.7—68.6 61	– –	29.6—39.1 34	65.4—78.1 72	74.4—75.8 75	56—75 66
Potatoes,	1	4	97	–	–	–	84	98

* Probably different products.

LITERATURE.

The following publications have been consulted in compiling the tables of the digestibility of American feed stuffs: —

Reports of Storrs (Connecticut) Experiment Station, 1894, 1895.

Reports of the Maine State Experiment Station for 1886, 1887, 1888, 1889, 1890, 1891, 1893, 1894.

Reports of the New York Experiment Station, 1884, 1888, 1889.

Reports of the Pennsylvania Experiment Station, 1887, 1888, 1889, 1890, 1891, 1892, 1893.

Bulletins Nos. 80 *c*, 81, 87 *d*, 97 and 118 of the North Carolina Experiment Station.

Bulletin No. 16, Utah Experiment Station.

Bulletin No. 3 of the Wisconsin Experiment Station for 1884, and Sixth Annual Report, 1889.

Bulletin No. 8 of the Colorado Experiment Station.

Bulletins Nos. 26 and 36 of the Minnesota Experiment Station.

Bulletin No. 6 of the Oregon Experiment Station.

Bulletins Nos. 13, 15 and 19 of the Texas Experiment Station.

Bulletins Nos. 20 and 41 of the Maryland Experiment Station.

Eleventh and Twelfth Annual Reports (1893 and 1894) of the Massachusetts State Experiment Station.

Report of Hatch Experiment Station, 1895, 1896.

Bulletin No. 43 of the Illinois Experiment Station.

REPORT OF THE CHEMIST.

DEPARTMENT OF FERTILIZERS AND FERTILIZER MATERIALS.

CHARLES A. GOESSMANN; Assistants: H. D. HASKINS, R. H. SMITH

PART I. FIELD EXPERIMENTS.

1. Experiments to study the effect of raising leguminous crops in rotation with grain crops on the nitrogen sources of the soil.
2. "Nitragin," a germ fertilizer for the cultivation of leguminous crops.
3. Observations with leguminous crops at Amherst.
4. Mixed annual forage crops *v.* clovers.
5. Experiments to study the economy of using natural phosphates in place of acid phosphates (superphosphates).
6. Experiments to ascertain the influence of different mixtures of chemical fertilizers on the character and yield of garden crops.

PART II. WORK IN THE CHEMICAL LABORATORY.

1. Report on inspection of commercial fertilizers.
2. New laws for the regulation of trade in commercial fertilizers.
3. Report on general work in the laboratory.
4. Compilation of analyses of manurial substances, fruits, garden crops and insecticides.

PART I.

REPORT ON FIELD EXPERIMENTS.

CHARLES A. GOESSMANN.

1. FIELD EXPERIMENTS CARRIED ON FOR THE PURPOSE OF STUDYING THE EFFECT OF A LIBERAL INTRODUCTION OF CLOVER-LIKE PLANTS — LEGUMINOUS CROPS — INTO FARM PRACTICE, AS A MEANS OF INCREASING THE RESOURCES OF AVAILABLE NITROGEN PLANT FOOD IN THE SOIL UNDER CULTIVATION FROM THE ELEMENTARY NITROGEN OF THE AIR. (*Field A.*)

The observation of the fact that the different varieties of clover and of clover-like plants in general, as peas, beans, vetches, lupines, etc., are in an exceptional degree qualified, under favorable conditions, to convert, by the aid of certain micro-organisms of the soil, the elementary nitrogen of the air into plant food, imparts to that class of farm crops a special interest from an economical stand-point. This circumstance is in a controlling degree due to the following two causes: —

First. — The nitrogen-containing soil constituents of plant food are, as a rule, in a high degree liable to suffer serious changes in regard to their character and fitness as well as in reference to their quantity.

Second. — Available nitrogen-furnishing manurial substances are the most costly articles of plant food in our markets.

Field experiments which propose to show, by their results, to what extent the cultivation of clover-like plants can be relied on as a practical and economical means for securing efficiently nitrogen plant food for the crops to be raised have

deservedly of late engaged the most careful attention of agricultural investigators.

The systematic treatment of the field here under consideration (Field A), as far as suitable modes of cultivation and of manuring are concerned, was introduced during the season of 1883 to 1884.

The subdivision of the entire area into eleven plats "one-tenth of an acre each," of a uniform size and shape, 132 feet long and 33 feet wide, with an unoccupied and unmanured space of 5 feet in width between adjoining plats, has been retained unaltered since 1884.

A detailed statement of the temporary aim and general management of the experiments, as well as of the results obtained in that connection from year to year, forms a prominent part of my contemporary printed annual reports, to which I have to refer for further details, 1884–96.

Our observations upon Field A are divided into three periods: —

(*a*) Study of the existing soil resources of plant food, 1884 to 1889.

(*b*) Study of the effect of excluding nitrogen plant food from outside sources and of adding nitrogen plant food in various available forms, 1889 to 1892.

(*c*) Studying the effect of the cultivation of leguminous crops on the resources of available nitrogen plant food in the soil under treatment, 1892 to 1897.

The first four years of the stated period 1884 to 1889 were principally devoted to an investigation into the general character and condition of the soil under cultivation as far as its natural and inherent resources of available phosphoric acid, nitrogen and potash were concerned.

The soil proved to be in particular deficient in potash. Different varieties of corn (maize) were raised in succession to assist in the investigation.

Since 1889 the main object of observation upon the same field has been to study the influence of an entire exclusion of any additional nitrogen-containing manurial substance from the soil under cultivation, as well as of a definite additional supply of nitrogen in different forms of combination on the character and yield of the crop selected for the trial.

Several plats (4, 7 and 9) which for five preceding years (1884 to 1889) had not received any nitrogen compound for manurial purposes, were retained in that state, to study the effect of an entire exclusion of nitrogen-containing manurial substances on the crop under cultivation; while the remaining ones received, as before, a definite amount of nitrogen in the same form in which they had received it in preceding years, namely, either as sodium nitrate (1, 2), as ammonium sulphate (5, 6, 8), as organic nitrogenous matter in form of dried blood (3, 10), or of barn-yard manure (0).

A corresponding amount of available nitrogen was applied in all these cases.

1889–94.

Plats.	Annual Supply of Manurial Substances per Plat (1-10 of one Acre).
Plat 0,	800 lbs. of barn-yard manure, 32 lbs. of potash-magnesia sulphate and 18 lbs. of dissolved bone-black.
Plat 1,	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 2,	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 3,	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 4,	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 5,	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 6,	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 7,	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 8,	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 9,	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 10,	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).

Amount of Fertilizing Ingredients used annually per Acre.

Plats 0, 1, 2, 3, 5, 6, 8, 10,	Nitrogen,	45 pounds.
	Phosphoric acid,	80 pounds.
	Potassium oxide,	125 pounds
Plats 4, 7, 9,	Nitrogen,	none.
	Phosphoric acid,	80 pounds
	Potassium oxide,	125 pounds.

The mechanical preparation of the soil, the incorporation of the manurial substances, the seeding, cultivating and harvesting, were carried on year after year in a like manner, and as far as practicable on the same day in case of every plat during the same year.

Kind of Crops raised.

Corn (maize),	in 1889.
Oats,	in 1890.
Rye,	in 1891.
Soy bean,	in 1892.

The annual yield of the various crops upon the different plats showed, as a rule, that those plats (4, 7, 9) which had not received in any form nitrogen for manurial purposes yielded much smaller crops than those that annually received in some form or other an addition of a corresponding amount of available nitrogen.

The total yield of crops on the plats receiving no nitrogen supply was, during the succeeding years, as follows: —

With corn in 1889, one-fifth less.

With oats in 1890, one-fifth to one-sixth less.

With rye in 1891, one-fifth to one-sixth less.

With soy bean in 1892, one-third to one-fourth less.

The results of four years (1889 to 1892) of observations were expressed in the following conclusions: —

The experiments carried on upon Field A during the years 1889, 1890, 1891 and 1892 show conclusively the importance of a liberal supply to the soil of an available form of nitrogen to secure a successful and remunerative cultivation of farm crops under otherwise corresponding favorable conditions. For even a leguminous crop, the soy bean, when for the first time raised upon Field A, did not furnish an exception to our observation (1892). (For details, see report for 1892.)

1893–97. — Subsequent to the year 1892, when for the first time in the more recent history of the field under discussion an *annual leguminous crop*, a late-maturing variety of soy bean, had been raised upon it, it seemed of interest to ascertain whether the raising of *the soy bean* upon Field A had increased the amount of available nitrogen stored up in

the soil to such an extent as to affect the yield of succeeding crops upon those plats (4, 7, 9) which, as a rule, had not received at any time for eight successive years an addition of available nitrogen from any other manurial source but the atmospheric air and the roots left in the soil after harvesting the crops raised.

A grain crop (oats) was selected as the crop suitable to serve for that purpose. The general management of the experiment, as far as the preparation of the soil, manuring and seeding-down are concerned, was the same as in previous years (see tenth annual report).

An examination of the yield of the crop in 1893, secured upon the different plats, showed that the total crop per acre on those plats to which no nitrogen was applied (4, 7, 9) averaged 800 pounds less than in case of the plats which received their regular supply of nitrogen in some form or other. The average yield of oats upon the plats (4, 7, 9) which had received no nitrogen supply from any outside source was *from one-seventh to one-eighth less in weight* than the average yield of the remaining plats, which received annually additional nitrogen supply.

From these results it appeared that the introduction of an annual leguminous crop into our rotation had somewhat reduced the difference in yield between the plats receiving no nitrogen and those receiving it, yet had not entirely obliterated it. It was decided to continue the observation by repeating the raising of soy beans in 1894, oats in 1895 and soy beans in 1896.

1894. — To secure, if possible, more decisive results regarding the presence and absence of available nitrogen, it was decided to use twice the amount of phosphoric acid and potassium oxide, as compared with the preceding years.

Amount of Fertilizing Ingredients applied per Acre during 1894.

Plats 0, 1, 2, 3, 5, 6, 8, 10,	Nitrogen,	45 pounds.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.
Plats 4, 7, 9,	Nitrogen,	none.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.

An early-maturing variety of soy bean was selected for the experiments. The fertilizer mixtures were applied as in previous years, broadcast, in the middle of April. Owing to the protracted drought of July and August the crop did not get that fulness of growth which might have been obtained under more favorable conditions. The crop was cut August 28.

The difference in the average yield of crop between the plats (4, 7, 9) which thus far had received no available nitrogen from outside manurial sources, as compared with that from those which had received it in some form or other, was more marked than in previous years. It amounted to one-third in favor of the latter.

1895. — In 1895 oats were again selected, as stated above, to succeed soy bean, for the reason of permitting a direct comparison of the results of 1892 (soy bean) and 1893 (oats) with those of 1894 (soy bean) and 1895 (oats).

The ploughing, manuring, seeding down, etc., was carried out in the same manner as during the preceding season (1894).

The average yield of the plats with and without nitrogen supply from outside sources showed that no material change in their relative degree of productiveness had taken place.

1896. — It was decided to substitute in our experiment a perennial leguminous plant, medium red clover, for the annual leguminous plant, the soy bean, to ascertain whether more satisfactory results will be secured from that change.

As a few years' observation are required to obtain a satisfactory basis for reliable conclusions, reports are deferred.

2. Experiments with "Nitragin," a Germ Fertilizer for the Cultivation of Clover and Clover-like Plants — Leguminous Crops.

The history of progress in agriculture shows that a more general and liberal introduction of clover and clover-like plants, as beans, peas, vetches, etc., as forage crops, into a general system of farm management has everywhere increased the chances of a more remunerative farming. The valuable investigations of Laws and Gilbert have furnished striking

proofs of the special claims of these crops as nitrogen gatherers when compared in that direction with grain crops.

The subsequent important discovery of the real cause of the exceptional behavior of these crops by Hellriegel and others has given not only a satisfactory explanation of previous observations in practical agriculture but has also imparted, for economical reasons, an increased interest in the study of successful methods of raising clovers, etc., without the aid of a liberal supply of nitrogen-containing manurial substances.

Hellriegel and his co-laborers established by careful observation the fact that leguminous plants, like clovers, beans, vetches, lupines, etc., with the assistance of certain micro-organisms (root bacterium) found in the soil, can utilize the elementary nitrogen of the air for the formation of nitrogen plant food fit for the support of their growth.

These micro-organisms fasten themselves upon the roots of the clover, etc., penetrate the epidermis and form in the course of their growth swellings, nodules or tubercles, of varying size and shape. Their presence and growth in the tissue of the roots of this stated class of plants is considered an essential condition for the conversion of the elementary nitrogen of the air into suitable nitrogen plant food. The recognition of the circumstance that their presence or absence in the soil controls the results in a material degree, even under otherwise favorable conditions, has turned the attention of progressive agriculturists towards the study of the circumstances which secure success.

Quite prominent among the more recent results of investigation in this direction are the observations that a variety of root bacterium exists ; that some infest the roots of one kind of leguminous plant while others thrive upon other kinds : that is to say, some leguminous crops may fail to give satisfactory returns where others prosper on account of the presence or absence of the right variety of root bacterium, or of suitable condition of the soil for their vigorous development.

These results caused the introduction of various modes of infecting the soil, wherever found necessary, with the desired kind of bacterium germ, before seeding down the new crop. A very common method consisted in scattering a

certain amount of soil, taken from a field where the crop to be raised has been successfully grown, over the surface of the new land before ploughing it. This method has been successfully practised by us on various occasions. Another is to abstract with water some of the soil, which from previous observation is known to contain the desired root bacterium germs, and sprinkle the watery extract over the soil before ploughing.

One of the latest developments in this direction is the appearance in the general market of patented germ fertilizer for leguminous crops. Considering the whole subject from a practical stand-point of sufficient interest, I insert below a copy of a circular received at this office. The connection of two German investigators of excellent reputation with the enterprise invites attention.

Three different kinds of germ fertilizers, for medium red clover, for crimson clover and for sweet or Bokhara clover, have been imported during the past season and are on trial upon the grounds of the station.

Nitragin.

Germ Fertilizers for Leguminous Crops.

(Prepared according to Drs. Nobbe and Hiltner.)

The principal food materials abstracted from the soil by plants, and which therefore require to be replaced in the form of manures, are potash, phosphoric acid, lime and nitrogen.

Respecting the last it has been known that leguminous crops, such as clover, vetches, peas, beans, lupines, etc., do not usually require to be manured with nitrogen (in form of nitre or ammoniacal compounds), and yet under favorable conditions yield rich harvests, whilst the soil is even enriched with nitrogen.

The reason of this peculiar behavior for many years remained unexplained, but the onward march of modern science has now demonstrated the ability of leguminous plants to abstract nitrogen from the air, only, however, by the aid of a specific kind of microorganism, a bacterium that resides in the characteristic nodules on the roots. If these bacteria are not at the disposal of the plant then it looses its ability to utilize the atmospheric nitrogen, and hence it is found that not every leguminous plant is able to flourish luxuriantly without nitrogenous manure; many remain small and stunted under conditions otherwise favorable, and evidently suffer from the lack of nitrogen.

It is therefore a matter of extreme importance to the farmer to make certain that each field of legumes is supplied with the necessary quantum of bacteria; only then can he expect to obtain full crops from poor sandy soils without nitrogen manures (*i. e., without saltpetre, ammonia, etc.*), *and only then will he reap the advantage of a soil enormously enriched with nitrogen.*

The wide bearing of this newly discovered principle has already been taken into practical consideration, and fields are now inoculated, that is to say, strewn with earth in which legumes have already flourished. This method, however, apart from its great cost and the loss of time and labor entailed, also involves the danger of disseminating injurious as well as useful bacteria.

This disadvantage is, however, now completely overcome by the pure patent germ fertilizer Nitragin, which consists of a pure cultivation of the specific bacteria of legume nodules in a suitable medium.

The inoculation of the seed or of the soil with the germ fertilizer, according to the directions given below, possesses the following advantages: —

1. Every single seed is surrounded with bacteria which, after germination, penetrate the root hairs and commence their role as collectors of nitrogen, so that a good crop is secured in the poorest soil without nitrogenous manures.

2. Through the storage of nitrogen by the bacteria, the soil itself becomes richer in nitrogen in an assimilable state, to the advantage of the other crops grown in rotation.

3. The disadvantages of the mode of inoculation previously adopted are avoided.

4. Manuring with nitrogen in the form of saltpetre, ammonium salts, etc., is absolutely unnecessary.

Directions for Use.

Every bottle contains sufficient for inoculation of $2\frac{1}{2}$ roods.

If the contents of the bottle have already become liquid, they are used as described below for the direct inoculation of the seed. If solid, the contents can be easily liquefied by warming the bottle gently for a few minutes, for instance, in the trousers' pocket, in tepid water or in a warm room. *Exposure to temperature above the heat of the body, which is amply sufficient to melt, or to direct sunlight must under all circumstances be strictly avoided.*

The liquid contents are poured into a vessel containing one to three pints of clean water (carefully washing out the whole contents of the bottle with a little water), and then shaken or stirred

until the fertilizer is equally distributed throughout the vessel and the bacteria are well mixed in the water.

The inoculated water thus prepared is poured over the seed and worked with the hands (or the shovel) until every seed has been moistened. If the quantity of water is insufficient more must be added, but usually for small seed a pint and a half will suffice and for large seeds two to three quarts. The moistened seed is then reduced to a condition suitable for sowing by mixing with some dry sand or fine earth and if necessary allowing it to stand, turning it over from time to time; too great dryness is deleterious. The sowing and turning in is carried out in the manner usually practised. If possible, however, avoid sowing in glaring sunlight.

Instead of inoculating the seed, the same and, in some cases, better results are obtained by inoculating the soil by means of inoculated earth. For this purpose for every 2½ roods one-half a hundred weight of earth is inoculated in the above-described manner, using a proportionately larger quantity of water; the inoculated earth is then dried in the air or mixed with dried earth, scattered equally over the field, and worked in three or four inches deep.

For larger surfaces than 2½ roods a corresponding number of bottles must be used (8 bottles to 5 acres).

As the bacteria are absolutely innocuous, there is no fear of danger from the bottles being left about or employed for other purposes.

Attention is specially directed to the fact that the "germ fertilizers" should only be used for the species of Leguminosœ marked on the label of the bottle. For greater distinction the bottles bear differently colored labels.

Manufactured by the Farbwerke vorm. Meister Lucius & Bruning, Hoechst on Main, Germany.

Specification of the Various Kinds of "Nitragin" (registered) Germ Fertilizers for Leguminous Crops.

Common pea (*Pisum sativum*), red label.
Sand pea (*Pisum arvense*), red label.
Common vetch (*Vicia sativa*), blue label.
Hairy vetch (*Vicia villosa*), blue label.
Common field bean or horse bean (*Vicia faba*), blue label.
White lupine (*Lupinus albus*), green label.
Yellow lupine (*Lupinus lutens*), green label.
Blue lupine (*Lupinus angustifolus*), green label.
Clover, red (*Trifolium pratense*), label gold on green.
White clover or Dutch clover (*Trifolium repens*), label gold on green.

Alsike clover (*Trifolium hybridum*), label gold on green.
Carnation clover or trifolium (*Trifolium incarnatum*), label gold on green.
Bokhara clover (*Melilotus alba*), label gold on green.
Black medick (*Medicago lupulina*), label gold on white.
Lucerne (alfalfa) (*Medicago sativa*), label gold on white.
Kidney vetch (*Anthyllis vulneraria*), label gold on white.
Sainfoin (*Onobrychis sativa*), gold label on violet.
Serradella (*Ornithopus sativus*), label gold on pink.
Wild everlasting pea (*Lathyrus sylvestris*), label gold on blue.

When giving your esteemed orders for Nitragin we shall thank you to state always, for what kind of leguminous crops you wish to receive the germ fertilizers.

Yours respectfully,
FARBWERKE VORM. MEISTER LUCIUS & BRUNING.

3. Observations with Leguminous Crops at Amherst.

The cultivation of leguminous crops has for years received special attention at our hands. The majority of reputed leguminous forage crops congenial to our climate have been raised repeatedly and on a sufficiently large scale in most instances to form a fair opinion regarding their merits as forage crops in our section of the country.

The following statement contains the kinds of leguminous crops experimented with at Amherst: —

Medium red clover (*Trifolium medium*).
Alsike clover (*Trifolium hybridum*).
Crimson clover (*Trifolium incarnatum*).
Japanese clover (*Lespedeza striata*).
Bokhara clover (sweet clover) (*Melilotus alba*).
Serradella (*Ornithopus sativus*).
Sainfoin (*Onobrychis sativa*).
Alfalfa (*Medicago sativa.*)
Scotch tares.
Lentil (*Ervum lens*).
Summer vetch (*Vicia sativa*).
Kidney vetch (*Anthyllis vulneraria*).
Horse bean (*Vicia faba*).
Early-maturing soy bean (*Soja hispida*).
Late-maturing soy bean (*Soja hispida*).
Peas (*Pisum sativum*).
Cow pea (*Dolichos sinensis*).
Flat pea (*Lathyrus sylvestris*).
White lupine (*Lupinus albus*).
Yellow lupine (*Lupinus luteus*).
Blue lupine (*Lupinus perennis*).

For details I have to refer to previous annual reports.

The following local observations are worth mentioning again on this occasion: —

(*a*) Alfalfa (*Medicago sativa*) and crimson clover (*Trifolium incarnatum*), in repeated trials, suffered seriously from winter-killing. This result has to be ascribed more to late frosts early in spring, when the ground is filled with water, than to the severity of mid-winter.

(*b*) Mixed crops of peas, vetch and horse bean, and vetch and oats or barley have given, as a rule, very satisfactory returns as far as quality and quantity are concerned.

(*c*) Soy beans, early and late varieties, have yielded, as a rule, during average seasons large crops; yet they have failed to enrich the soil they were raised upon sufficiently in available nitrogen plant food to secure under otherwise corresponding conditions, as far as the supply of available potash and phosphoric acid is concerned, as high a yield of a succeeding crop of rye, oats, barley and even soy bean, as where from forty to fifty pounds per acre of an available form of nitrogen were added. The liberal addition of nitrates to the soil interfered with a liberal development of root tubercles, in case of soy bean, in a well-infected soil.

Similar results are reported by other investigators in regard to lupines followed by oats or potatoes; an addition of nitrates in connection with a potash and phosphoric acid containing fertilizer increased the yield. The infection of the soil by lupine bacterium did not benefit the growth of other leguminous crops.

The belief that each variety of leguminous crop is associated with a root bacterium of its own finds support in the circumstance that the root tubercles of different varieties of these crops quite frequently vary, not only in size and shape but in their mode of distribution over the main roots or rootlets. Illustrations of this feature have been furnished by the writer in form of photographs from nature in case of soy bean, horse bean, lupines, etc., (see State station report for 1894).

Much has been learned regarding the symbiotic or combined life of root bacteria and leguminous plants, yet much further investigation in the vegetation house and the field

is evidently needed *to secure to the full extent* and with certainty the economical advantages to be derived from the raising of crops which are capable of converting, without expense, the elementary nitrogen of the air into available nitrogen plant food.

Our attention, as will be seen from preceding statements, has been of late directed to the question *whether perennial leguminous crops, as our current varieties of clovers*, may prove more satisfactory as nitrogen gatherers for general farm purposes than annual leguminous crops, as soy bean, lupines, etc.

4. Mixed Annual Forage Crops v. Clovers (*Field B*).

The importance of a more liberal and economical supply of nutritious forage crops for the support of farm live stock is quite generally recognized by all parties interested.

Mixed forage crops, consisting of early-maturing annual leguminous crops, clover-like plants and of either oats or barley, suggested themselves for trial; for they attain in our locality a high feeding value at a comparatively early period of the season, — towards the end of June when in bloom; they can serve with benefit in form of green fodder, hay or ensilage, as circumstances advise; they yield under fair conditions large quantities of fodder of a highly nutritious character, and permit a timely reseeding and maturing of a second crop upon the same lands.

The fields used for our earlier observations, in 1893–94, were located in different parts of the farm. They were, as a rule, in a fair state of cultivation, as far as the mechanical condition of the soil as well as its store of plant food was concerned. The soil consisted in the majority of cases of a somewhat gravelly loam (see reports for 1893–94).

The field used in the experiments, subsequently described somewhat in detail, consisted of a light loam and was divided into eleven plats of corresponding shape with four feet of unoccupied space between them. It was used for the cultivation of potatoes in preceding years. The plats had received on that occasion in all cases the same amount and form of nitrogen and phosphoric acid, in form of ground bones, while the potash supply consisted in alternating

order of plats either of muriate of potash or of high-grade sulphate of potash, containing the same amount of potassium oxide in every case (400 pounds of muriate of potash, 80 to 82 per cent., or of high-grade sulphate of potash, 95 per cent., and 600 pounds of fine-ground bones per acre). This system of manuring the plats has been followed ever since 1893. The same crops have been raised each season upon adjoining plats to notice the particular effect of both forms of potash on the crop raised (for details see previous reports).

Vetch and Oats and Vetch and Barley.

1894. — The same amount and kind of manure were applied for raising vetch and oats and vetch and barley. The field occupied by these crops was ploughed, manured, harrowed and seeded down, as far as practicable, at the same time. The seed was sown in all cases April 26. Four bushels of oats with 45 pounds of vetch were sown, as on previous occasions, while 3 bushels of barley were used with 45 pounds of vetch per acre in case of barley and vetch. Both crops came up May 4 and were of a uniformly healthy condition during their subsequent growth. The barley began to head out June 20; the vetch was at that time beginning to bloom. The crop was cut for hay June 23.

It needs no further statement to understand that the quality of the seeds and of the soil ought to be considered in deciding about weights of the former. Close cultivation is desirable in case of this class of forage crops, for it favors a succulent, tender structure and keeps weeds out.

Average Yield of Crops.

Yield of Barley and Vetch per Acre.

In case of muriate of potash and bone, . .	5,737 pounds of hay.
In case of sulphate of potash and bone, . .	5,077 pounds of hay.

The oats headed out June 25; the vetch was fairly in bloom at this time. The crop was cut for hay July 2.

Yield of Oats and Vetch per Acre.

In case of muriate of potash and bone, . .	8,051 pounds of hay.
In case of sulphate of potash and bone, . .	7,088 pounds of hay.

1895. — During that year the observations of the preceding year were repeated and in some directions enlarged; oats, vetch and horse bean, and oats and lentils were added to those of the preceding year. The same kind and quantity of manures were applied. The field was ploughed April 25 and the manure harrowed in May 3; the seed was sown broadcast May 9. All parts of the field were treated alike, and as far as practicable on the same day. The plats occupied by the crops were in all cases 33 feet wide, with 4 feet unoccupied space between them, and from 191 to 241 feet long. The yield of areas 175 feet long and 33 feet wide, running along by the side of each other, served as our basis for comparing results (5,775 square feet) (for details see report for 1895).

Yield of Vetch and Oats per Acre.

In case of muriate of potash and bone, ...	7,238 pounds.
In case of sulphate of potash and bone, ...	6,635 pounds.

Yield of Vetch, Horse Bean and Oats per Acre.

In case of muriate of potash and bone, ...	7,398 pounds.
In case of sulphate of potash and bone, ...	5,881 pounds.

Yield of Oats and Lentils per Acre.

The experiment was confined to a trial with sulphate of potash and bone as manure on account of want of a suitable field. The yield was 5,881 pounds of hay.

After the crops stated had been harvested, during the middle of July, in the form of hay, the field was ploughed and prepared for the cultivation of a variety of clovers, mammoth red clover, medium red clover, alsike or Swedish clover, crimson clover and sweet or Bokhara clover, to compare the crops resulting during two succeeding years with those obtained in case of mixed crops of vetch and oats, etc.

The subdivision of the field into eleven plats was the same as in the preceding year; each plat received the same kind and amount of fertilizer as before; the mechanical preparation of the soil was in all cases the same. The seeding down of the different plats took place on the same day, July 23, 1895.

Plats 11 and 12 were each seeded down with 3 pounds of sweet clover seed.

Plats 13 and 14 were each seeded down with 3 pounds of mammoth red clover seed.

Plats 15 and 16 were each seeded down with 3 pounds of medium red clover seed.

Plats 17 and 18 were each seeded down with 2½ pounds of alsike or Swedish clover seed.

Plats 19 and 20 were each seeded down with 4 pounds of crimson or scarlet clover.

Plats 11, 13, 15, 17 and 19 received their potash in form of muriate of potash (80 to 82 per cent.); plats 12, 14, 16, 18 and 20 in form of high-grade sulphate of potash (95 per cent.).

Subsequent History of Crops on Different Plats.

Plats 11 and 12. — The frost affected the crop somewhat by heaving of the soil; the growth was thin and of a light color except in some instances where a deep color and large growth was noticed. A subsequent examination showed in these cases an exceptional development of tubercles on the roots. The crop was harvested June 19.

Plat 11. — Crop weighed green 200 pounds.

Plat 12. — Crop weighed green 285 pounds.

On account of unsatisfactory condition of the plats both were ploughed July 15 and reseeded on July 30, 1896, with 10 pounds of sweet clover seed each, to notice whether a more liberal infection of the soil with suitable bacterium thus secured would result in better and larger returns. Nov. 1, 1896, the crop was looking well and was one foot in height. The dark spots of growth had spread greatly.

Plats 13 and 14. — The crops upon these plats looked well in the fall and during the succeeding spring. The crop was cut before it had reached full bloom, June 23, on account of its being badly lodged; they were harvested as hay June 29.

Total Yield of Hay.

PLATS.	Yield of Hay (Pounds).	Yield of Rowen (Pounds).	Total Yield of Dry Matter (Pounds).
13,	615	295	756.65
14,	650	305	796.32

The sod looked well on both plats Nov. 1, 1896.

Plats 15 and 16. — The crop looked healthy in the fall and in the succeeding spring; the crop was cut when in full bloom, June 19, and harvested June 23. The rowen was cut July 28 and harvested July 30. A third crop was cut October 9 and harvested October 26.

Total Yield of Hay.

PLATS.	Yield of Hay (Pounds).	Yield of Second Crop (Pounds).	Yield of Third Crop (Pounds).	Total Yield of Dry Matter (Pounds).
15,	455	276	120	686.62
16,	455	294	120	720.55

The sod looked to be in good condition on both plats Nov. 1, 1896.

Plats 17 and 18. — The crop looked well from the beginning and was in bloom June 7. The hay was cut and harvested June 19 and 23.

Total Yield of Hay.

PLATS.	Yield of Hay (Pounds).	Yield of Rowen (Pounds).	Total Yield of Dry Matter (Pounds).
17,	620	325	733.21
18,	455	200	518.56

Nov. 1, 1896, the sod looked exhausted and was covered with weeds and sorrel.

Plats 19 and 20. — These plats looked well in early winter but almost every plant died out in early spring. The plats were reseeded during the month of April, 1896, with 5½ pounds of seed on each plat. The hay was cut when in bloom July 17 and harvested July 23. The crop was in poor condition when cut and never sprouted again.

Total Yield of Hay.

PLATS.	Yield of Hay (Pounds).	Total Yield of Dry Matter (Pounds).
19, ...	575	422.91
20, ...	595	406.94

Summary of Yield of Crops in 1896 (Dry Matter).

[Pounds.]

PLATS.	Hay.	Rowen.	Total Yield of Dry Matter.
11, ...	–	–	–
12, ...	–	–	–
13, ...	511.62	245.03	756.65
14, ...	541.58	254.74	796.32
15, ...	373.46	313.16	686.62
16, ...	390.12	330.43	720.55
17, ...	458.49	274.72	733.21
18, ...	356.54	162.02	518.56
19, ...	422.91	–	422.91
20, ...	406.94	–	406.94

5. Field Experiments with Different Commercial Phosphates, to study the Economy of using the Cheaper Natural Phosphates or the More Costly Acidulated Phosphates. (*Field F.*)

The field selected for this purpose is 300 feet long and 137 feet wide, running on a level from east to west. Previous to 1887 it was used as a meadow, which was well worn out at that time, yielding but a scanty crop of English hay. During the autumn of 1887 the sod was turned under and left in that state over winter. It was decided to prepare the field for special experiments with phosphoric acid by systematic exhaustion of its inherent resources of plant food. For this reason no manurial matter of any description was applied during the years 1887, 1888 and 1889.

The soil, a fair sandy loam, was carefully prepared every year by ploughing during the fall and in the spring, to improve its mechanical condition; during the same period a crop was raised every year. These crops were selected, as far as practicable, with the view to exhaust the supply of phosphoric acid in particular. Corn, Hungarian grass and leguminous crops (cow pea, vetch and serradella) followed each other in the order stated.

In 1890 the field was subdivided into five plats, running from east to west, each 21 feet wide with a space of 8 feet between adjoining plats. The manurial material applied to each of these five plats contained, in every instance, the same form and the same quantity of potassium oxide and nitrogen, while the phosphoric acid was furnished in each case in the form of a different commercial phosphoric-acid-containing article, namely, phosphatic slag, Mona guano, Florida phosphate, South Carolina phosphate, floats and dissolved bone-black. The market cost of each of these articles in 1890 controlled the quantity applied, for each plat received the same money value of its particular kind of phosphate. The phosphatic slag, Mona guano, South Carolina phosphate, floats and Florida phosphate were applied at the rate of 850 pounds per acre, dissolved bone-black at the rate of 500 pounds per acre. Nitrate of soda was applied at the rate of 250 pounds per acre and potash-magnesia sulphate at the

rate of 390 pounds per acre. (For the analysis of phosphates and cost of each in 1890 see report for 1895.)

The following fertilizer mixtures have been applied annually, from 1890 to 1894, to all plats, with the exception of Plat 3, which received in 1890 ground apatite and in 1891 no phosphate whatever, on account of the failure of securing in time apatite suitable for the trial.

PLATS.	Annual Supply of Manurial Substances.	Pounds.
Plat 1 (south, 6,494 square feet),	Ground phosphatic slag,	127
	Nitrate of soda,	43
	Potash-magnesia sulphate,	58
Plat 2 (6,565 square feet),	Ground Mona guano,	128
	Nitrate of soda,	43½
	Potash-magnesia sulphate,	59
Plat 3 (6,636 square feet),	Ground Florida phosphate,	129
	Nitrate of soda,	44
	Potash-magnesia sulphate,	59
Plat 4 (6,707 square feet),	South Carolina phosphate,	131
	Nitrate of soda,	44½
	Potash-magnesia sulphate,	60
Plat 5 (6,778 square feet),	Dissolved bone-black,	78
	Nitrate of soda,	45
	Potash-magnesia sulphate,	61

Names of Crops raised from 1890 to 1894.

1890, potatoes (see eighth annual report of Massachusetts State station); 1891, winter wheat (see ninth annual report of Massachusetts State station); 1892, serradella (see tenth annual report of Massachusetts State station); 1893, Dent corn, Pride of the North (see eleventh annual report of Massachusetts State station).

Summary of Yield of Crops (Pounds).

PLATS.	1890. Potatoes.	1891. Wheat.	1892. Serradella.	1893. Corn.
Plat 1, phosphatic slag,	1,600	380	4,070	1,660
Plat 2, Mona guano,	1,415	340	3,410	1,381
Plat 3, Florida phosphate,	1,500	215	2,750	1,347
Plat 4, South Carolina floats,	1,830	380	3,110	1,469
Plat 5, dissolved bone-black,	2,120	405	2,920	1,322

Having for four years (1890–94) in succession pursued the above-stated system of manuring each plat with a differ-

ent kind of phosphate, yet of corresponding money value, it was decided to continue the experiments for the purpose of studying the *after-effect* of the different phosphates on the crops to be raised. To gain this end the phosphates were hereafter in all cases entirely excluded from the fertilizers applied; in addition to this change, the former amount of potash and nitrogen was increased one-half in quantity, to favor the highest effect of the stored-up phosphoric acid in the soil under treatment.

The fertilizers hereafter used had the following composition: —

Plat 1 (6,494 square feet), ...	64½ pounds of nitrate of soda. 87 pounds of potash-magnesia sulphate.
Plat 2 (6,565 square feet), ...	65¼ pounds of nitrate of soda. 88 pounds of potash-magnesia sulphate.
Plat 3 (6,636 square feet), ...	66 pounds of nitrate of soda. 89 pounds of potash-magnesia sulphate.
Plat 4 (6,707 square feet), ...	66¾ pounds of nitrate of soda. 90 pounds of potash-magnesia sulphate.
Plat 5 (6,778 square feet), ...	67½ pounds of nitrate of soda. 90½ pounds of potash-magnesia sulphate.

The results of three years (1894 to 1896) are as follows: —

Barley.

Yield of Crop (1894).

Plats.	Grain and Straw (Pounds).	Grain (Pounds).	Straw and Chaff (Pounds).	Percentage of Grain.	Percentage of Straw.
Plat 1, ...	490	169	221	34.49	65.51
Plat 2, ...	405	148	251	34.07	65.93
Plat 3, ...	290	78	212	26.89	73.11
Plat 4, ...	460	144	216	31.30	68.70
Plat 5, ...	390	118	272	30.26	69.74

Rye.

Yield of Crop (1895).

Plats.	Grain and Straw (Pounds).	Grain (Pounds).	Straw and Chaff (Pounds).	Percentage of Grain.	Percentage of Straw.
Plat 1, ...	695	195	500	28.06	71.94
Plat 2, ...	631	166	465	26.31	73.69
Plat 3, ...	383	143	240	37.34	62.66
Plat 4, ...	759	189	570	24.90	75.10
Plat 5, ...	625	185	440	29.60	70.40

Medium Green Soy Bean.

Yield of Crop (1896).

Plats.	Whole Crop (Pounds).	Beans (Pounds).	Straw, etc. (Pounds).	Percentage of Beans.	Percentage of Straw, etc.
Plat 1, ...	680	254	426	37.20	62.80
Plat 2, ...	773	233	540	30.14	69.86
Plat 3, ...	717	262	455	36.54	63.46
Plat 4, ...	752	252	500	33.51	66.49
Plat 5, ...	742	247	495	31.94	68.06

Summary of Yield of Crops (1890 to 1896).

[Pounds.]

Plats.	1890. Potatoes.	1891. Wheat.	1892. Serradella.	1893. Corn.	1894. Barley.	1895. Rye.	1896. Soy Bean.
Plat 1, phosphatic slag,	1,600	380	4,070	1,660	490	695	254
Plat 2, Mona guano, .	1,415	340	3,410	1,381	405	630	233
Plat 3, Florida phosphate.	1,500	215	2,750	1,347	290	383	262
Plat 4, South Carolina phosphate (floats).	1,830	380	3,110	1,469	460	759	252
Plat 5, dissolved bone-black.	2,120	405	2,920	1,322	390	625	247

Conclusions.

From the previous statement of comparative yields for average successive years we find that the plat receiving dissolved bone-black leads in yield during the first two years while the third, fourth, fifth and sixth years the plats receiving phosphates insoluble in water are ahead, phosphatic slag being first, with South Carolina floats second.

The following statement regarding the phosphoric acid applied in the case of each plat, and also the amount removed from them by the crops raised, shows approximately how much the former is still stored up in the soil in each plat, not considering the original inherent amount in the soil at the beginning of the trial: —

Phosphoric Acid applied to and removed from Field (Pounds).

PLATS.	1890. Potatoes.		1891. Wheat.		1892. Serradella.		1893. Corn.		Total Amount added.	Total Amount removed.	Total Amount remaining.
	Added.	Removed.	Added.	Removed.	Added.	Removed.	Added.	Removed.			
Plat 1, .	24.18	2.56	24.18	1.23	24.18	8.95	24.18	7.20	96.72	19.94	77.78
Plat 2, .	28.01	2.36	28.01	1.19	28.01	7.50	28.01	6.33	72.04	17.38	54.66
Plat 3, .	109.68	2.40	-	.69	28.01	6.05	28.01	5.95	165.70	15.09	150.61
Plat 4, .	36.12	2.93	36.12	1.31	36.12	6.84	36.12	6.68	144.48	18.12	126.36
Plat 5, .	12.34	3.39	12.34	1.22	12.34	6.42	12.34	6.05	49.36	17.08	32.28

Phosphoric Acid applied to and removed from Field (Pounds) — Concluded.

PLATS.	1894. Barley.		1895. Rye.		1896. Soy Bean.		Total Amount added.	Total Amount removed.	Total Amount remaining.
	Added.	Removed.	Added.	Removed.	Added.	Removed.			
Plat 1, . . .	-	1.92	-	3.41	-	5.84	96.72	31.11	65.61
Plat 2, . . .	-	1.64	-	3.04	-	5.75	72.04	27.81	44.23
Plat 3, . . .	-	.76	-	2.06	-	6.07	165.70	23.98	141.72
Plat 4, . . .	-	1.72	-	3.61	-	6.01	144.48	29.46	115.02
Plat 5, . . .	-	1.49	-	3.11	-	5.89	49.36	27.57	21.79

The experiment needs continuation to secure more decisive results.

6. Field Experiments to ascertain the Influence of Different Mixtures of Commercial Fertilizers on the Yield and General Character of Several Prominent Garden Crops.

The area devoted to the above-stated experiment is 198 feet long and 183 feet wide; it is subdivided into six plats of uniform size (89½ by 62 feet, or about one-eighth of an acre each). The plats are separated from each other and from the adjoining cultivated fields by a space of 5 feet of unmanured and unseeded yet cultivated land.

They are arranged in two parallel rows, running from east to west. Plats Nos. 1, 2 and 3 are along the north side of the field, beginning with No. 1 at its west end, while plats Nos. 4, 5 and 6 are located along its south side, beginning with Plat 4 on the west end. The soil is several feet deep, and consists of a light, somewhat gravelly loam, and was in a fair state of productiveness when assigned for the experiment here under consideration. The entire field occupied by the experiment is nearly on a level. Potatoes and a variety of forage crops have been raised upon it in preceding years. The manure applied since 1885 has consisted exclusively of fine-ground bone and muriate of potash, annually, 600 pounds of the former and 200 pounds of the latter per acre.

The observation with raising garden crops by aid of the different mixtures of commercial manurial substances, here under special consideration, began upon plats Nos. 4, 5 and 6 during the spring of 1891, and upon plats Nos. 1, 2 and 3 during that of 1892.

The difference of the fertilizers applied consisted in the circumstance that the different forms of nitrogen and potash were used for their preparation. All plats received essentially the same quantity of nitrogen, potash and phosphoric acid, and every one of them received its phosphoric acid in the same form, namely, dissolved bone-black. Some plats received their nitrogen supply in form of organic animal matter, dried blood; others in form of sodium nitrate, Chili saltpetre; others in the form of ammonium sulphate. Some plats received their potash in the form of muriate of potash

(plats 1, 2, 3), and others (plats 4, 5, 6) in the form of the highest grade of potassium sulphate (95 per cent.). The subsequent tabular statement shows the quantities of manurial substances applied to the different plats: —

Plats.	Annual Supply of Manurial Substances.	Pounds.
Plat 1,	Sulphate of ammonia,	38
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 2,	Nitrate of soda,	47
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 3,	Dried blood,	75
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 4,	Sulphate of ammonia,	38
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 5,	Nitrate of soda,	47
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 6,	Dried blood,	75
	Sulphate of potash,	30
	Dissolved bone-black,	40

This proportion corresponds per acre to: —

	Pounds.
Phosphoric acid (available),	50.4
Nitrogen,	60.0
Potassium oxide,	120.0

A computation of the results of a chemical analysis of twenty prominent garden crops shows the average relative proportion of the three above-stated ingredients of plant food: —

	Per Cent.
Nitrogen,	2.2
Potassium oxide,	2.0
Phosphoric acid,	1.0

One thousand pounds of green garden vegetables contain on the above-stated basis of relative proportion of essential constituents of plant food: —

	Pounds.
Nitrogen,	4.1
Potassium oxide,	3.9
Phosphoric acid,	1.9

The weights and particular stage of growth of the vegetables when harvested control, under otherwise corresponding conditions, the actual consumption of each of these articles of plant food. Our information regarding these points is still too fragmentary to enable a more detailed statement here beyond relative proportions. It must suffice for the present to call attention to the fact that a liberal manuring within reasonable limits pays, as a rule, better than a scanty one, especially in the case of those crops which reach in a short period the desired state of maturity.

The various mixtures of fertilizers used in the experiments under discussion provided by actual supply for one-half of the available nitrogen actually called for to meet the demand as above pointed out. A liberal cultivation of peas and beans cannot fail to benefit the nitrogen resources of the soil. The order of arrangement of the different crops within each plat was the same in all of them for the same year.

They occupied, however, a different position relative to each other in successive years, to introduce, as far as practicable, a system of rotation of crops. (For details see previous annual report.)

Statement of Crops raised since 1891.

1891 and 1892.	1893.	1894.	1895 and 1896.
Celery.	Onions.	Onions.	Onions.
Lettuce.	Lettuce.	Sweet corn.	Sweet corn.
Spinach.	Spinach.	–	–
Beets.	Beans.	Beans.	Beans.
Cabbage.	–	–	–
Tomatoes.	Tomatoes.	Tomatoes.	Tomatoes.
Potatoes.	Potatoes.	–	–

Season of 1896. — The field was ploughed April 20. The fertilizers were the same as in the preceding years; each of the six plats received the same amount and kind of fertilizer, which was harrowed in April 24.

The crops raised during the season of 1896 were: —

Onions (Danvers Globe).
Tomatoes (Dwarf Champion).
Beans (Dwarf Horticultural).
Sweet Corn (Early Crosby).

Onions.

The seed was sown April 28. Each plat contained fifteen rows 14 inches apart; the weeds were kept down by frequent use of the hand cultivator; the crop was weeded by hand twice; the crop was rolled September 7. Those plats (4, 5, 6) which received their potash supply in form of high-grade sulphate of potash matured first, while those plats (1, 2, 3) receiving muriate of potash matured somewhat later. The crop upon Plat 1 was the latest to mature, while that upon Plat 2, receiving nitrate of soda, was the most advanced plat in the field. The onions were pulled September 7, topped October 5 and weighed October 9.

Yield of Onions (Pounds).

PLATS.	Large Onions.	Small Onions.	Scullions.	Total Yield.
Plat 1, . .	490	29	100	628
Plat 2, . .	697	24	30	751
Plat 3, . .	659	49	60	768
Plat 4, . .	489	26	55	570
Plat 5, . .	494	21	30	545
Plat 6, . .	595	54	50	699

Tomatoes.

It was deemed best in this experiment to procure an earlier maturing variety than the one used in the preceding year, to meet our market demands. The plants were started at the plant house of the horticultural department. The plants were set May 21 3 to 4 feet apart, two rows in each plat; each plat contained 44 plants; they were cultivated five times and hand-hoed three times.

Field C. Yield of Tomatoes (Pounds).

DATE OF PICKING.	Plat 1.	Plat 2.	Plat 3.	Plat 4.	Plat 5.	Plat 6.
July 18, ...	–	–	.40	–	–	.14
July 22, ...	.40	–	.12	–	–	.12
July 25, ...	1.10	.30	1.11	.30	.13	.12
July 28, ...	2.12	1.00	2.80	2.60	2.10	6.40
July 30, ...	3.20	2.10	2.80	1.14	4.00	3.40
August 1, ...	4.00	6.00	3.40	5.00	8.00	4.00
August 3, ...	8.40	6.80	8.80	7.00	5.80	7.00
August 5, ...	8.12	8.40	9.00	7.60	10.40	9.40
August 8, ...	10.12	15.00	15.00	13.80	17.00	18.00
August 10, ...	17.40	13.80	11.00	14.00	12.12	19.40
August 12, ...	7.40	8.80	5.00	12.00	13.40	9.40
August 15, ...	13.80	25.00	21.40	34.00	32.12	25.12
August 17, ...	17.00	44.80	21.12	45.00	49.40	36.12
August 19, ...	9.00	16.80	22.40	17.00	22.12	17.12
August 21, ...	6.12	14.80	18.40	7.80	15.40	8.40
August 24, ...	12.80	31.00	18.80	21.80	39.40	30.40
August 26, ...	13.12	33.80	17.00	20.00	35.80	26.80
August 29, ...	Not weighed.*	36.00	Not weighed.*	32.00	33.40	27.12
September 1, ...		50.80		49.12	68.40	53.00
September 4, ...		55.80		61.00	63.40	77.00
September 7, ...		48.80		44.00	54.00	63.00
September 11, ...		37.00		46.80	47.40	51.12
September 16, ...		34.00		55.00	35.00	42.00
September 21, ...		7.00		10.00	9.80	12.00
Green tomatoes, ...	28.00	10.80	40.00	24.00	9.00	14.00

* Records not complete.

Beans.

The beans were planted in rows 2½ feet apart, there being seven rows in each plat. The seed was planted May 19, the young plants appeared above ground June 1; they were cultivated five times and hand-hoed three times; the beans on all plats alike rusted badly. The beans were pulled and stacked in the field August 19.

Yield of Beans (Pounds).

PLATS.	Beans.	Pods and Vines.	Total Weight.
Plat 1, ...	31	30	61
Plat 2, ...	53	44	97
Plat 3, ...	52	44	96
Plat 4, ...	58	45	103
Plat 5, ...	67	51	118
Plat 6, ...	48	42	90

Sweet Corn.

Each plat contained five rows, the latter being 3 feet 3 inches apart; the hills were 20 inches apart, there being three plants left in each hill, making 1,060 hills per plat.

The crop appeared above ground June 1. It was subsequently cultivated five times and hand-hoed three times. In order to hasten maturity the stalks were topped September 9.

The corn was harvested and weighed October 9 with the following results: —

Sweet Corn (Early Crosby). Yield in Pounds per Plat.

PLATS.	Ears.	Stover.	Total Weight.
Plat 1, ...	190.0	250	445.0
Plat 2, ...	240.0	280	520.0
Plat 3, ...	195.0	335	530.0
Plat 4, ...	190.0	310	500.0
Plat 5, ...	182.5	290	472.5
Plat 6, ...	190.0	302	492.0

Conclusions drawn from Four Years of Observation.

1. Sulphate of potash in connection with nitrate of soda (Plat 5) has given in every case but one (onions) the best results.

2. Nitrate of soda as nitrogen source (plats 2 and 5) has yielded in almost every case, without reference to form of potash, the best results.

3. Sulphate of ammonia as a nitrogen source, in connection with muriate of potash as source of potash (Plat 1), has given as a rule the least satisfactory returns. This fact is evidently due to a change of chloride of potash and sulphate of ammonia into sulphate of potash and chloride of ammonium, the latter being an unfavorable form of nitrogen plant food.

4. The influence of the difference in the general character of the weather, whether normal or dry, during succeeding seasons on the yield of the crops has been greater than that of the different fertilizers used upon different plats during the same season.

Note. — The general management of the field work connected with the previously described continuation of my experiments was attended to by Mr. H. M. Thomson, Assistant Agriculturist of the Hatch Experiment Station, to whom I take pleasure in expressing my thanks for his cheerful assistance.

Part II.

REPORT ON THE WORK IN THE CHEMICAL LABORATORY.

Charles A. Goessmann.

1. On Official Inspection of Commercial Fertilizers and Agricultural Chemicals in 1896.

During the past year fifty-seven manufacturers and dealers in commercial fertilizers and agricultural chemicals have applied for and secured licenses for the sale of their goods in the State. Thirty-three of these parties have offices for general distribution within our State, nine in the State of New York, six in Connecticut, three in Vermont, three in Rhode Island, two in Pennsylvania and one in Illinois.

The number of distinct brands licensed, including agricultural chemicals, amounted to two hundred and sixty-five.

The sampling and collecting of the material for official analyses were in charge of Mr. H. D. Haskins, a graduate of the Massachusetts Agricultural College of the year 1890, and an efficient assistant in the chemical laboratory of the division of chemistry of the Experiment Station, who for several years in the past has attended to that part of the inspection in a very satisfactory manner.

Three hundred and twenty-eight samples were collected during the year, of which three hundred, representing two hundred and fifteen distinct brands, have been analyzed, and the results published in three bulletins, March, July and October, Numbers 38, 40 and 42 of the Hatch Experiment Station of the Massachusetts Agricultural College.

The modes of analyses adopted in this work were in all essential points those recommended by the Association of Official Chemists.

The results of the inspection have been on the whole quite satisfactory, as far as the compliance of the dealers with the provisions of our State laws for the regulation of the trade in commercial fertilizers is concerned. The variations here and there noticed between the guaranteed composition of the dealer and the results of our analyses could be traced with but few exceptions to imperfect mixing of the several ingredients of the fertilizer, and did not, as a rule, materially affect the commercial value of the article. In this connection attention should be called to the fact that the lowest amount stated in the guarantee is only legally binding.

To convey a more direct idea of the actual condition of this feature in the trade of commercial fertilizers of 1896, the following detailed statement is here inserted: —

(*a*) Where three essential elements of plant food were guaranteed: —

Number with three elements equal to or above the highest guarantee,	3
Number with two elements above the highest guarantee,	18
Number with one element above the highest guarantee,	65
Number with three elements between the lowest and highest guarantees,	26
Number with two elements between the lowest and highest guarantees,	60
Number with one element between the lowest and highest guarantees,	42
Number with two elements below the lowest guarantee,	8
Number with one element below the lowest guarantee,	59

(*b*) Where two essential elements of plant food were guaranteed: —

Number with two elements above the highest guarantee,	–
Number with one element above the highest guarantee,	16
Number with two elements between the lowest and highest guarantees,	13
Number with one element between the lowest and highest guarantees,	10
Number with one element below the lowest guarantee,	10

(*c*) Where one essential element of plant food was guaranteed: —

Number above the highest guarantee,	4
Number between the lowest and highest guarantees,	21
Number below the lowest guarantee,	11

The consumption of commercial fertilizers is steadily increasing, — a circumstance apparently not less due to a more general recognition of their good services, if judiciously selected and applied, than to gradual improvements in regard to their mechanical condition as well as their general chemical character. A noticeable change, referred to already in a previous report, regarding the chemical composition of many brands of so-called complete or formula fertilizers of to-day, as compared with those offered for similar purposes at an earlier period in the history of the trade in commercial fertilizers, consists in a more general and more liberal use of potash compounds as a prominent constituent. This change has been slow but decided, and in a large degree may be ascribed to the daily increasing evidence, resting on actual observations in the field and garden, that the farm lands of Massachusetts are quite frequently especially deficient in potash compounds, and consequently need in many instances a more liberal supply of available potash from outside sources to give satisfactory returns. Whenever the cultivation of garden vegetables, fruits and forage crops constitutes the principal products of the land, this recent change in the mode of manuring deserves in particular a serious trial; for the crops raised consume exceptionally large quantities of potash, as compared with grain crops. In view of these facts, it will be conceded that a system of manuring farm and garden which tends to meet more satisfactory recognized conditions of large areas of land, as well as the special wants of important growing branches of agricultural industries, is a movement in the right direction.

The present condition of the trade in commercial fertilizers offers exceptional advantages to provide efficient manures for the raising of farm and garden crops of every description congenial to soil and climate. The various essential articles of plant food, as potash, phosphoric acid and nitrogen compounds, are freely offered for sale in forms suitable to render the different kinds of the home manurial refuse material of the farm in a higher degree fit to meet the special wants of the crops to be raised.

Mixed fertilizers, designed to supply the essential articles of plant food with reference to the needs of special crops,

and containing them in every conceivable proportion, are asking for the patronage of all parties interested in the raising of plants.

A judicious management of the trade in commercial fertilizers implies a due recognition of well-established experimental results regarding the requirements of a remunerative production of farm and garden crops; yet, as the manufacturer at best can only prepare the composition of his special fertilizers on general lines, not knowing the particular condition and character of the soil which ultimately receives them, it becomes of the utmost importance on the part of the farmer to make himself acquainted with his special wants of manurial substances, and to thus qualify himself for a more judicious selection from the various fertilizers offered for his patronage.

For the reason that the physical conditions and chemical resources of soils on available plant food are frequently differing widely even on the same farm, no definite rule can be given for manuring farm lands, beyond the advice to return to the soil those plant constituents which the crops raised during preceding years have abstracted in an exceptionally large proportion, and which at the same time will be especially called for by the crops to be raised.

To select judiciously from among the agricultural chemicals and mixed fertilizers offered for sale for home use requires, in the main, three kinds of information: —

First. — A knowledge of the condition and the character of the soil to be prepared for cultivation.

Second. — An acquaintance with the composition of the crops, as far as the essential elements of plant food they contain are concerned.

Third. — A fair information regarding the general character, as well as the special composition, of the manurial substances offered for sale are concerned.

To assist as far as practicable in obtaining the above-stated desirable information, a compilation of the composition of our most prominent farm and garden crops, as well as the manurial substances and agricultural chemicals found in our markets, has been published from time to time in our annual reports, and will be found at the close of the present one.

List of Manufacturers and Dealers who have secured Certificates for the Sale of Commercial Fertilizers in This State during the Past Year (May 1, 1896, to May 1, 1897), and the Brands licensed by Each.

The Armour Fertilizer Works, Chicago, Ill.: —
Bone Meal.
Bone and Blood.
Ammoniated Bone and Potash.
All Soluble.
Bone, Blood and Potash.
Old Bog Cranberry Manure.

American Fertilizer Company, Boston, Mass.: —
Anti Acid Phosphate.
Alkaline Nitrate Phosphate for Hoed Crops.
Alkaline Nitrate Phosphate for Hay and Grain Crops.
Ward's Inodorous Plant Food.
Muriate of Potash.

Wm. H. Abbott, Holyoke, Mass.: —
Abbott's Fertilizer.
Abbott's Eagle Brand Fertilizer.

Bartlett & Holmes, Springfield, Mass.: —
Pure Ground Bone.
Animal Fertilizer.

H. J. Baker and Brother, New York, N. Y.: —
Standard Un X Ld Fertilizer.
Complete Strawberry Manure.
Complete Onion Manure.
Complete Potato Manure.
Complete Corn Manure.
A A Ammoniated Superphosphate.
Complete Tobacco Manure.
Grass and Lawn Dressing.
Vegetable, Vine and Potato Special.
Ground Bone.

C. A. Bartlett, Worcester, Mass.: —
Pure Ground Bone.
Animal Fertilizer.

The Berkshire Mills, Bridgeport, Conn.: —
- Ammoniated Bone Phosphate.
- Complete Fertilizer.

Bowker Fertilizer Company, Boston, Mass.: —
- Stockbridge Special Manures.
- Bowker's Hill and Drill Phosphate.
- Bowker's Farm and Garden Phosphate.
- Bowker's Lawn and Garden Dressing.
- Bowker's Fish and Potash.
- Bowker's Potato and Vegetable Manure.
- Bowker's Market-garden Manure.
- Bowker's Sure Crop Bone Phosphate.
- Gloucester Fish and Potash.
- Bowker's Dry Ground Fish.
- Bowker's Fresh Ground Bone.
- Nitrate of Soda.
- Dried Blood.
- Dissolved Bone-black.
- Muriate of Potash.
- Sulphate of Potash.
- Sulphate of Ammonia.

Bradley Fertilizer Company, Boston, Mass.: —
- Bradley's X L Superphosphate.
- Bradley's Potato Manure.
- Bradley's B D Sea Fowl Guano.
- Bradley's Complete Manures.
- Bradley's Fish and Potash.
- Bradley's High-grade Tobacco Manure.
- English Lawn Fertilizer.
- Farmers' New Method Fertilizer.
- Breck's Lawn and Garden Dressing.
- Sulphate of Potash.
- Muriate of Potash.
- Nitrate of Soda.
- Sulphate of Ammonia.
- Dissolved Bone-black.
- Fine-ground Bone.

William E. Brightman, Tiverton, R. I.: —
- Brightman's Potato and Root Manure.
- Brightman's Phosphate.
- Brightman's Fish and Potash.

B. L. Bragg & Co., Springfield, Mass. : —
Hampden Lawn Dressing.

Butchers' Rendering Association, Saugus, Mass. : —
Ground Bone.
Champion Garden Fertilizer.

Daniel T. Church, Providence, R. I. : —
Church's B Special Fertilizer.
Church's C Standard Fertilizer.
Church's D Fish and Potash.

Clark's Cove Fertilizer Company, Boston, Mass. : —
Bay State Fertilizer.
Bay State Fertilizer, G G Brand.
Great Plant Manure.
Potato and Tobacco Manure.
King Philip Guano.
Potato Manure.
Fish and Potash.
White Oak Pure Ground Bone.
Muriate of Potash.
Sulphate of Potash.
Nitrate of Soda.

The Cleveland Dryer Company, Boston, Mass. : —
Cleveland Superphosphate.
Cleveland Potato Phosphate.
Cleveland Fertilizer.

E. Frank Coe Company, New York, N. Y. : —
E. Frank Coe's Excelsior Potato Fertilizer.
E. Frank Coe's High-grade Potato Fertilizer.
E. Frank Coe's Special Fertilizer.
E. Frank Coe's High-grade Ammoniated Bone Superphosphate.
E. Frank Coe's Fish Guano and Potash.
E. Frank Coe's Bay State Ammoniated Bone Superphosphate.
E. Frank Coe's Bay State High-grade Potato Fertilizer.

Crocker Fertilizer and Chemical Company, Buffalo, N. Y. : —
Crocker's General Crop Phosphate.
Crocker's New England Tobacco Grower.

Crocker Fertilizer and Chemical Company, Buffalo, N. Y. — *Concluded.*
Muriate of Potash.
Coolidge Brothers' Special Truck Fertilizer.
Crocker's Ammoniated Bone Superphosphate.
Crocker's Potato, Hop and Tobacco Phosphate.
Crocker's Special Potato Manure.
Crocker's Pure Ground Bone.
Crocker's Practical Ammoniated Superphosphate.
Crocker's New Rival Ammoniated Superphosphate.
Crocker's Ammoniated Wheat and Corn Phosphate.
Crocker's Ground Bone Meal.
Crocker's Vegetable Bone Superphosphate.

Cumberland Bone Phosphate Company, Boston, Mass.: —
Cumberland Superphosphate.
Cumberland Potato Fertilizer.
Cumberland Concentrated Phosphate.
Cumberland Fertilizer.

L. B. Darling Fertilizer Company, Pawtucket, R. I.: —
Animal Fertilizer.
Extra Bone Phosphate.
Potato and Root Fertilizer.
Lawn and Garden Fertilizer.
Tobacco Grower.
Pure Fine Bone.
Pure Dissolved Bone.
Sulphate of Potash.

John C. Dow & Co., Boston, Mass.: —
Superphosphate.
Pure Bone.
Bone Fertilizer.

Fyfe, Fay & Plummer, Clinton, Mass.: —
Canada Wood Ashes.

Great Eastern Fertilizer Company, Rutland, Vt.: —
Great Eastern General Fertilizer.
Northern Corn Special.
Soluble Bone and Potash.
Vegetable, Vine and Tobacco Fertilizer.
Garden Special Fertilizer.

Thomas Hersom & Co., New Bedford, Mass.: —
Bone Meal.

John G. Jefferds, Worcester, Mass.: —
Jefferds' Fine Ground Bone.
Jefferds' Potato Manure.
Jefferds' Animal Fertilizer.

Thomas Kirley, South Hadley Falls, Mass.: —
Kirley's Pride of the Valley.

A. Lee & Co., Lawrence, Mass.: —
The Lawrence Fertilizer.

Lowell Fertilizer Company, Lowell, Mass.: —
Lowell Bone Fertilizer.
Lowell Animal Fertilizer.
Lowell Potato Phosphate.
Lowell Vegetable and Vine Fertilizer.
Lowell Lawn Dressing.
Dissolved Bone and Potash.
Complete Manure for Potatoes and Vegetables.

Lowe Brothers & Co., Fitchburg, Mass.: —
Tankage.

The Mapes Formula and Peruvian Guano Company, New York, N. Y.: —
The Mapes Superphosphates.
The Mapes Bone Manures.
The Mapes Special Crop Manures.
Sulphate of Potash.
Double Manure Salts.
Nitrate of Soda.
Economical Manure.
Lawn Top-dressing with Plaster.

E. McGarvey & Co., successors to Forest City Wood Ash Company, Boston, Mass.: —
Unleached Wood Ashes.

McQuade Brothers, West Auburn, Mass.: —
Pure Ground Bone.

Monroe, Lalor & Co., Oswego, N. Y.: —
Unleached Wood Ashes.

National Fertilizer Company, Bridgeport, Conn.: —
Chittenden's Complete Fertilizers.
Chittenden's Ammoniated Bone.
Chittenden's Market-garden Fertilizer.
Chittenden's Fish and Potash.
Chittenden's Ground Bone.
Chittenden's Potato Phosphate.

Niagara Fertilizer Company, Buffalo, N. Y.: —
Niagara Wheat and Corn Producer.
Niagara Triumph.
Niagara Grain and Grass Fertilizer.
Niagara Potato, Tobacco and Hop Fertilizer.

Packers' Union Fertilizer Company, New York, N. Y.: —
Animal Corn Fertilizer.
University Fertilizer.
Oats and Clover Fertilizer.
Potato Manure.
Gardeners' Complete Manure.

Pacific Guano Company, Boston, Mass.: —
Soluble Pacific Guano.
Special Potato Manure.
Nobsque Guano.
Special for Potatoes and Tobacco.
Fish and Potash.
High-grade General Fertilizer.

Parmenter & Polsey Fertilizer Company, Peabody, Mass.: —
Plymouth Rock Brand.
Special Potato Fertilizer.
Special Strawberry Manure.
Star Brand Fertilizer.
Lawn Dressing.
Ground Bone.
Nitrate of Soda.
Muriate of Potash.

E. W. Perkins & Co., Rutland, Vt.: —
Plantene.

Prentiss, Brooks & Co., Holyoke, Mass.: —
Complete Manures.
Phosphate.
Nitrate of Soda.
Dissolved Bone-black.
Muriate of Potash.
Sulphate of Potash.
Fish and Potash.
Dry Ground Fish.

Preston Fertilizer Company, Green Point, L. I.: —
Pioneer Fertilizer.
Ammoniated Superphosphate.
Potato Fertilizer.

Quinnipiac Company, Boston, Mass.: —
Potato Manure.
Market-garden Manure.
Ammoniated Dissolved Bones.
Fish and Potash (Crossed Fishes).
Fish and Potash (Plain Brand).
Havana Tobacco Fertilizer.
Grass Fertilizer.
Corn Manure.
Potato and Tobacco Fertilizer.
Onion Manure.
Pure Bone Meal.
Dry Ground Fish.
Tankage.
Muriate of Potash.
Sulphate of Potash.
Nitrate of Soda.
Sulphate of Ammonia.
Dissolved Bone-black.
Phosphate.

Read Fertilizer Company, New York, N. Y.: —
Read's Standard.
High-grade Farmers' Friend.
Fish and Potash.
Vegetable and Vine Fertilizer.
Practical Potato Special Fertilizer.

N. Roy & Son, South Attleborough, Mass. : —
Complete Animal Fertilizer.

The Rogers & Hubbard Company, Middletown, Conn. : —
Pure Raw Knuckle Bone Flour.
Strictly Pure Fine Bone.
Soluble Potato Manure.
Soluble Tobacco Manure.
Fertilizer for Oats and Top-dressing.
Fairchild's Formula for Corn and General Crops.
Grass and Grain Fertilizer.

Russia Cement Company, Gloucester, Mass. : —
XXX Fish and Potash.
High-grade Superphosphate.
Special Manure for Potatoes, Roots and Vegetables.
Special Manure for Corn, Grain and Grass.
Odorless Lawn Dressing.
Dry Ground Fish.

Lucien Sanderson, New Haven, Conn. : —
Dissolved Bone-black.
Muriate of Potash.
Sulphate of Potash.
Nitrate of Soda.
Blood, Meat and Bone.
Formula A.

M. L. Shoemaker & Co., Limited, Philadelphia, Penn. : —
Swift and Sure Phosphate.
Swift and Sure Bone Meal.

Edward H. Smith, Northborough, Mass. : —
Fine-ground Bone.

Standard Fertilizer Company, Boston, Mass. : —
Standard Fertilizer.
Potato and Tobacco Fertilizer.
Standard Guano.
Fine-ground Bone.
Complete Manure.

Thomas L. Stetson, Randolph, Mass. : —
Fine-ground Bone.

F. C. Sturtevant, Hartford, Conn. : —
Ground Tobacco Stems.

Henry F. Tucker & Co., Boston, Mass.: —
Original Bay State Bone Superphosphate.
Imperial Bone Superphosphate.
Special Potato Fertilizer.

Walker, Stratman & Co., Pittsburg, Penn.: —
Potato Special.
Four Fold.
Smoky City.
Meadow King.

I. S. Whittemore, Wayland, Mass.: —
Whittemore's Complete Manure.

The Wilcox Fertilizer Works, Mystic, Conn.: —
Potato, Onion and Tobacco Manure.
Ammoniated Bone Phosphate.
High-grade Fish and Potash.
Dry Ground Fish Guano.
Fish and Potash, 1896 Brand.
Low-grade Sulphate of Potash.

Williams & Clark Fertilizer Company, Boston, Mass.: —
Superphosphate.
Potato Phosphate.
High-grade Special.
Fine Wrapper Tobacco Fertilizer.
Royal Bone Phosphate.
Corn Phosphate.
Potato and Tobacco Manure.
Grass Manure.
Fish and Potash.
Universal Ammoniated Dissolved Bone.
Prolific Crop Producer.
Onion Manure.
Pure Bone Meal.
Dry Ground Fish.
Tankage.
Muriate of Potash.
Sulphate of Potash.
Nitrate of Soda.
Dissolved Bone-black.
Sulphate of Ammonia.

M. E. Wheeler & Co., Rutland, Vt.: —
- High-grade Fruit Fertilizer.
- Grass and Oats Fertilizer.
- Electrical Dissolved Bone.
- Potato Manure.
- High-grade Corn Fertilizer.
- Superior Truck Fertilizer.

2. New Laws for the Regulation of the Trade in Commercial Fertilizers in Massachusetts.

[Acts of 1896, Chapter 297.]

An Act to regulate the Sale of Commercial Fertilizers.

Be it enacted, etc., as follows:

Section 1. Every lot or parcel of commercial fertilizer or fertilizer material sold or offered or exposed for sale within this Commonwealth shall be accompanied by a plainly printed statement, clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand or trade-mark under which the fertilizer is sold, the name and address of the manufacturer or importer, the location of the factory, and a chemical analysis stating the percentage of nitrogen, of potash soluble in distilled water, and of phosphoric acid in available form soluble in distilled water and reverted, as well as the total phosphoric acid. In the case of those fertilizers which consist of other and cheaper materials said label shall give a correct general statement of the composition and ingredients of the fertilizer it accompanies.

Sect. 2. Before any commercial fertilizer is sold or offered or exposed for sale the importer, manufacturer or party who causes it to be sold or offered for sale within this Commonwealth shall file with the director of the Hatch experiment station of the Massachusetts Agricultural College a certified copy of the statement named in section one of this act, and shall also deposit with said director at his request, a sealed glass jar or bottle, containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

Sect. 3. The manufacturer, importer, agent or seller of any brand of commercial fertilizer or fertilizer material shall pay for each brand, on or before the first day of May annually, to the director of the experiment station, an analysis fee of five dollars for each of the three following fertilizing ingredients: namely, nitrogen, phosphorus and potassium, contained or claimed to exist in said brand of fertilizer: *provided*, that whenever the manufact-

urer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee named in this section; and on receipt of said analysis fees and statement specified in section two the director of said station shall issue certificates of compliance with this act.

SECT. 4. No person shall sell or offer or expose for sale in this Commonwealth any pulverized leather, hair or wool waste, raw, steamed, roasted or in any form as a fertilizer, or as an ingredient of any fertilizer or manure, without an explicit printed certificate of the fact, said certificate to be conspicuously affixed to every package of such fertilizer or manure, and to accompany or go with every parcel or lot of the same.

SECT. 5. Any person selling or offering or exposing for sale any commercial fertilizer without the statement required by the first section of this act, or with a label stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, or respecting the sale of which all the provisions of the foregoing section have not been fully complied with, shall forfeit fifty dollars for the first offence and one hundred dollars for each subsequent offence.

SECT. 6. This act shall not affect parties manufacturing, importing or purchasing fertilizers for their own use and not to sell in this Commonwealth.

SECT. 7. The director of the experiment station shall pay the analysis fees, as soon as received by him, into the treasury of the station, and shall cause one analysis or more of each fertilizer or fertilizer material to be made annually, and shall publish the results from time to time, with such additional information as the circumstances render advisable, provided such information relates only to the composition of the fertilizer or fertilizer material inspected. Said director is hereby authorized in person or by deputy to take a sample, not exceeding two pounds in weight, for analysis, from any lot or package of fertilizer or fertilizer material which may be in the possession of any manufacturer, importer, agent or dealer; but said sample shall be drawn in the presence of said party or parties in interest, or their representative, and taken from a parcel or a number of packages which shall be not less than ten per cent. of the whole lot inspected, and shall be thoroughly mixed and then divided into two equal samples and placed in glass vessels, and carefully sealed and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was

drawn, and the time and place of drawing; and said label shall also be signed by the director or his deputy and by the party or parties in interest, or their representatives present at the drawing and sealing of said sample; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled. All parties violating this act shall be prosecuted by the director of said station.

SECT. 8. Chapter two hundred and ninety-six of the acts of the year eighteen hundred and eighty-eight is hereby repealed.

SECT. 9. This act shall take effect on the first day of November in the year eighteen hundred and ninety-six. [*Approved April 17, 1896.*]

3. General Work in the Chemical Laboratory.

Analyses of materials sent on for examination.

Notes on basic phosphatic slag ("slag meal") as a fertilizer.

Action of chloride of potassium (muriate of potash) and chloride of sodium (common salt) on the lime resources of the soil.

Effect of chloride of potassium on sulphate of ammonium in mixed fertilizers.

Analyses of Materials sent on for Examination.

The constantly increasing variety of waste products of many branches of industry within our State and elsewhere, which have proved of manurial value, has received for years a serious attention. As a change in the current modes of manufacture of the parent industry is at any time liable to seriously affect the character and chemical composition of the waste or by products, it becomes necessary to repeat from time to time analyses of many of these products. These analyses are made, as far as our resources allow, without any charge for the work, on the condition that the results are public property if deemed of interest for publication.

A brief enumeration of the more prominent substances sent on for our investigation during the year 1896 may serve to convey a correct idea concerning the extent and importance of the labor involved. The whole number of substances analyzed in this connection during the year 1896 to December 1 amounts to 175: wood ashes, 51; cotton-seed-hull ashes, 7; swill ashes from cremation furnace, 1; rock phosphate, 4; acid phosphate, 4; phosphatic slag, 2; ground bones, tank-

age, dried fish and blood, 18; cotton-seed and linseed meal, 19; barn-yard manure, solid and liquid, 11; cotton waste from factories, 6; potash salts of various descriptions, 18; dry Bordeaux mixtures, 10; Paris green, 8; miscellaneous analyses, 10; and compound fertilizers, 21.

The responsibility of the genuineness of all samples sent on for examination rests with the parties asking for analyses; the name of the localities they come from appears only in our published records of the work to prevent misunderstandings. The samples of fertilizers collected by responsible parties under the direction of the officer of this department alone are entered on our list of official analyses.

Notes on Basic Phosphatic Slag ("Slag Meal") as a Fertilizer.

This article appeared for the first time in our markets in 1886 under the name of phosphatic meal made of the Peine-Thomas Scoria, a by-product of a new process introduced into the manufacture of iron and steel from phosphorus containing iron ores.

The first sample received by me at Amherst was marked "R. Weichsel & Co., Magdeburg, Germany; phosphate meal made of the Peine-Thomas Scoria, guaranteed by Dr. Ulex of Hamburg, Germany, to contain 21.41 per cent. of phosphoric acid, corresponding to 46.74 per cent. of bone phosphate; Paul Weidinger & Co., New York, acting as agents."

The first lot sent on for field experiments consisted of 500 pounds of ground slag meal, also a mixture of 500 pounds of slag meal with 500 pounds of kainite; to the latter had been added some dry ground peat, to prevent caking. Pure slag meal, it is claimed, never hardens after being ground.

As the process of dephosphorizing the iron requires that the slag should be alkaline from the beginning, an excess of lime enters into the composition of the slag. To the presence of a certain amount of burned lime the phosphate meal owes, evidently, some of its good effects as a phosphoric acid source for plant food; incorporated in the soil, it absorbs moisture, and, like burned lime, it breaks up into an impal-

pable powder, which cannot fail to increase the availability of its phosphoric acid in a marked degree, as compared with other non-acidulated ground phosphates.

Not less beneficial must be considered in many instances the alkaline reaction of the genuine material, for it secures favorable conditions not only for a rapid decomposition ("nitrification") of the organic matter of the soil, but also for the disintegration of valuable mineral constituents of the soil, rendering in both directions inherent plant food more available. Much attention has been paid in Germany and England to experiments with slag meal as a phosphoric acid source of plant food, and many satisfactory results are reported. Our own observations are, to say the least, very encouraging, as may be seen from several annual reports since 1887.

Mixtures of phosphatic slag with nitrate of soda and the higher grades of potash salts have given in many instances much satisfaction. To secure the full benefit of the action of slag meal, it is desirable to scatter it broadcast late in the fall or early in the spring, and to plough it under at once from three to four inches; nitrate of soda and potash salts may be harrowed in later on, previous to seeding down.

The high price (from $20 to $25 per ton) of late charged for phosphatic slag meal of a varying composition and general character has discouraged its trial, as compared with the ground phosphate of South Carolina and Florida. As the high price has greatly interfered with a more general trial of slag meal, it is of interest to learn that arrangements are announced which will result in introducing large supplies of it at a much lower cost than before. A German syndicate, claiming to own the right of patent regarding the sale of Thomas slag in Europe and the United States, has established an office in Philadelphia, Penn., address Charles A. Voight, P. O. box 2133, Station A. In a recent communication from him it is stated the article will be offered for sale at from $8 to $9 per ton to farmers in the eastern States. The material consists of a dark, fine powder; it is sent out in 200 pound bags, with a guarantee of 18 per cent. of phosphoric acid. The station has secured a quantity for trial during the coming season.

Analysis of Phosphatic Slag Meal.

[I. Analyses of above-stated sample, 1896; II. Average of four analyses of earlier dates.]

	Per Cent.	
	I.	II.
Moisture,	1.45	1.45
Total phosphoric acid,	17.88	23.49
Calcium oxide (lime),	43.74	48.66
Magnesium oxide,	–*	3.42
Ferric and aluminic oxides,	25.25	10.12
Insoluble matter,	9.93	9.40

* Not determined.

Action of Chloride of Potassium (Muriate of Potash) and Chloride of Sodium (Common Salt) on the Lime Resources of the Soil.

In a previous bulletin, No. 38, issued March, 1896, by the Hatch Experiment Station, I called attention to an observation in connection with some field experiments, which showed that in several instances where, under otherwise corresponding circumstances, for several years muriate of potash had been liberally used as a potash source for a variety of crops, instead of sulphate of potash, an unhealthy appearance and lower yield of crop became from year to year more apparent. To correct this feature, from 350 to 400 pounds per acre of dry slacked lime were scattered broadcast over the surface of the soil, and ploughed under before manuring and seeding down the crop. The addition of lime gave excellent satisfaction, for the new crop looked healthy and vigorous, and the yield of the crop increased again fully to the average amount of the field. An examination of the drainage waters confirmed the view taken in the treatment of the field; the chlorides of calcium and magnesium were noticed to form prominent constituents of the

solid residue left after its evaporation. The amount of lime noticed in the drainage waters where muriate of potash had been added as a potash source was in every instance larger than where corresponding amounts of high-grade sulphate of potash were applied.

In publishing the results of our observations the following conclusions were offered for the consideration of farmers: —

(*a*) *The claim of both muriate and sulphate of potash, being economical and efficient forms to supply potash for growing crops, is so well established that no further endorsement is called for in this connection. Each form has its special merits with reference to particular fitness in case of different crops.*

(*b*) *The liberal use of muriate of potash as a fertilizer constituent renders, in cases where the lime resources of the soil under cultivation are limited, a periodical direct application of lime compounds as a manurial matter advisable.*

(*c*) *Muriate of potash is a safer source for manurial purposes upon a deep soil with a free subsoil than upon a shallow soil with a compact clayish subsoil, on account of a possible accumulation of the highly objectionable chlorides of calcium and magnesium (lime and magnesia) near the roots of the plants; both are known to prevent a healthy development of the root system.*

Repeated observations in the field and in the laboratory tend to confirm the above-stated conclusions; chloride of sodium (common salt) behaves in the same way as the chloride of potassium, — a fact which is readily proved by adding to any kind of a soil which is free from the chlorides of calcium some ground chalk and common salt, and after a week or so collecting and analyzing the percolating water; the presence of carbonic acid favors greatly the reaction; no good agricultural soil is free from carbonic acid or bicarbonates of lime and magnesium.

Effect of Chloride of Potassium (Muriate of Potash) on Sulphate of Ammonium in Mixed Fertilizers.

In studying the influence of the following mixtures of fertilizing materials, *i. e.*, —

PLATS.	Annual Supply of Manurial Substances.	Pounds.
Plat 1,	Sulphate of ammonia,	38
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 2,	Nitrate of soda,	47
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 3,	Dried blood,	75
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 4,	Sulphate of ammonia,	38
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 5,	Nitrate of soda,	47
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 6,	Dried blood,	75
	Sulphate of potash,	30
	Dissolved bone-black,	40

on the yield and character of a variety of garden crops, it was noticed, with but one or two exceptions, that the fertilizers on Plat 1, consisting of dissolved bone-black, sulphate of ammonium and muriate of potash, produced the lowest yield of crop on trial; while the fertilizers on Plat 4, composed of corresponding quantities of dissolved bone-black, sulphate of ammonium and high-grade sulphate of potash, yielded, as a rule, a fair average crop. (For details, see preceding annual reports since 1892.)

As the season, character of the soil and mode of cultivation were practically the same in all cases, it seemed but natural to conclude that the fertilizers applied to Plat 1 suffered an unfavorable change when incorporated in the soil. An actual trial proved that a dry mixture of muriate of potash and sulphate of ammonium dissolved in water changes into sulphate of potash and chloride of ammonium (sal ammoniac); this form of nitrogen is known to act unfavorably on growing plants.

Most of our agricultural chemicals are liable to suffer chemical changes when used in mixed fertilizers; these changes are frequently not less depending on a mutual reac-

tion upon each other than on the general character and the particular chemical composition of the soil which receives them. The results of the chemical reactions between the saline constituents of the fertilizers and of the soil are as apt to benefit the crop as to injure it; the above-described observation furnishes an illustration of an injurious influence. Sulphate of ammonium is evidently a safer source of nitrogen for plant growth when used in connection with sulphate of potash than when used with muriate of potash (chloride of potassium).

4. Compilation of Analyses of Agricultural Chemicals, Manurial Substances, Fruits, Garden Crops and Insecticides.

Prepared by H. D. Haskins, Assistant Chemist, Hatch Experiment Station.

1868 to 1897.

This compilation does not include the analyses made of licensed fertilizers. They are to be found in the reports of the State Inspector of Fertilizers from 1873 to 1896, contained in the reports of the Secretary of the Massachusetts State Board of Agriculture for those years, and in the bulletins of the department of chemistry of the Hatch Experiment Station of the Massachusetts Agricultural College since March, 1895.

As the basis of valuation changes from year to year, no valuation is stated in this compilation.

C. A. GOESSMANN.

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
I. Chemicals, Refuse, Salts, Ashes, etc.																							
Muriate of potash,	81	1.77	-	-	-	-	58.98	45.94	**51.00**	-	-	-	-	-	-	6.69	-	.55	-	-	-	48.80	.70
Sulphate of potash,	38	1.86	-	-	-	-	51.30	21.36	**40.21**	-	-	-	-	-	-	4.46	-	1.50	-	45.72	-	-	.75
Sulphate of potash-magnesia,	28	4.81	-	-	-	-	29.48	16.96	**24.82**	-	-	-	-	-	-	6.25	2.57	-	-	44.25	-	2.60	1.41
Carbonate of potash,	1	26.88	-	-	-	-	-	-	**18.48**	-	-	-	-	-	-	-	-	19.52	-	-	-	-	.39
Phosphate of potash,	1	3.76	-	-	-	-	-	-	**32.56**	-	-	**37.50**	-	-	-	-	-	-	-	13.43	-	-	.92
Kainite,	5	3.18	-	-	-	-	16.48	12.51	**13.56**	-	-	-	-	-	-	18.97	1.15	9.80	-	20.25	-	33.25	2.13
Carnallite,	1	-	-	-	-	-	-	-	**13.68**	-	-	-	-	-	-	7.66	-	13.19	-	.56	-	41.56	-
Krugite,	1	4.82	-	-	-	-	-	-	**8.42**	-	-	-	-	-	-	5.27	12.45	8.79	-	31.94	-	6.63	14.96
Sulphate of magnesia (Kieserite),	9	22.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.82	17.30	-	36.10	-	-	5.73
Nitrate of potash,	4	1.30	-	14.58	11.60	**12.71**	45.62	44.76	**45.27**	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate of soda,	37	1.38	-	16.22	14.28	**15.04**	-	-	-	-	-	-	-	-	-	35.50	-	-	-	-	-	.50	.50
Sulphate of ammonia,	28	1.06	-	21.68	19.59	**22.03**	-	-	-	-	-	-	-	-	-	-	-	-	-	60.00	-	-	-
Phosphate of ammonia,	1	6.05	-	-	-	**10.37**	-	-	-	-	-	**43.86**	-	-	-	-	-	-	-	12.46	-	-	.82
Sulphate of soda,	1	1.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	59.43	-	-	-
Saltpetre waste,	12	2.54	-	3.30	.52	**2.22**	30.94	1.55	**13.66**	-	-	-	-	-	-	37.04	.75	.19	-	1.85	-	46.25	-
Nitre salt-cake,	2	6.03	-	-	-	**2.29**	-	-	**.87**	-	-	-	-	-	-	29.56	-	-	-	47.77	-	-	3.92

Wood ashes,	527	10.38	-	-	-	-	10.80	1.20	5.39	5.58	.05	1.51	-	-	-	-	33.55	3.31	.96	-	-	-	16.28
Cotton-seed-hull ashes,	56	8.60	-	-	-	-	42.12	9.08	22.55	22.38	2.89	8.59	-	-	-	-	9.39	10.47	1.76	-	-	-	13.44
Ashes of spent tan-bark,	5	4.84	-	-	-	-	2.87	.60	1.81	2.77	.13	1.36	-	-	-	-	31.11	3.39	1.78	-	-	-	25.21
Corn-cob ashes,	1	1.20	-	-	-	-	-	-	7.08	-	-	2.37	-	-	-	-	11.70	-	1.28	-	-	-	52.09
Railroad-tie ashes,	1	4.70	-	-	-	-	-	-	.92	-	-	.56	-	-	-	-	2.51	-	-	-	-	-	80.20
Peat ashes,	1	4.67	-	-	-	-	-	-	.46	-	-	.11	-	-	-	-	2.28	1.63	6.13	-	-	-	45.17
Logwood ashes,	1	1.50	-	-	-	-	-	-	.08	-	-	2.30	-	-	-	-	3.90	-	-	-	-	-	9.70
Hard-pine wood ashes,	1	.75	-	-	-	-	-	-	10.16	-	-	2.24	-	-	-	-	24.95	-	-	-	-	-	29.90
Mill ashes,	1	.53	-	-	-	-	-	-	1.60	-	-	.46	-	-	-	-	34.93	1.35	-	-	-	-	36.36
Ashes from cremation of swill,	15	4.86	-	-	-	-	8.83	1.25	3.97	32.36	7.47	14.16	-	-	-	-	33.58	1.87	4.65	-	-	-	21.57
Ashes from blue works,	1	12.14	63.78	-	-	-	-	-	9.02	-	-	-	-	-	-	-	-	-	-	-	-	-	12.30
Sea-weed ashes,	1	1.47	-	-	-	-	-	-	.92	-	-	.30	-	-	-	8.76	6.06	4.37	-	2.98	-	6.60	63.65
Gypse,	1	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50.87	-	-	-	-	-	2.87
Nova Scotia plaster (gypsum),	16	8.95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32.85	.75	-	44.87	-	-	3.47
Onondaga plaster (New York gypsum),	4	13.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.00	4.66	-	32.50	8.20	-	9.83
Lime,	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	93.63	-	-	-	-	-	1.33
Waste lime,	1	.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	74.12	-	-	-	-	-	.38
Gas-house lime,	3	22.28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43.66	8.30	-	20.73	-	-	6.05
Lime waste from sugar factory,	1	36.30	-	-	-	-	-	-	.22	-	-	2.25	-	-	-	-	27.51	-	-	-	-	-	.32
Lime kiln ashes,	17	14.48	-	-	-	-	2.78	.02	1.28	3.16	.36	1.09	-	-	-	-	42.57	2.60	-	-	17.75	-	7.69
Bituminous coal ashes,	2	3.66	-	-	-	-	-	-	.38	-	-	.44	-	-	-	-	1.88	-	-	-	-	-	74.17
Carbonate of lime,	1	.47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52.98	-	-	-	-	-	-

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
I. Chemicals, Refuse, Salts, Ashes, etc. — Concluded.																							
Marls (Massachusetts),	7	13.70	-	-	-	-	-	-	.24	2.72	.06	**1.05**	-	-	-	-	40.50	.64	.69	-	28.57	-	3.44
Marls (Virginia),	2	15.98	-	-	-	-	.61	.37	**.49**	.09	.08	**.09**	-	-	-	-	7.25	.21	-	.66	7.25	-	64.23
Green sand marl (Virginia),	1	1.25	-	-	-	-	-	-	**1.14**	-	-	**9.37**	-	-	-	-	25.78	-	5.13	-	-	-	41.32
Olive earth (Virginia),	1	1.97	-	-	-	-	-	-	**.24**	-	-	**13.73**	-	-	-	-	19.16	-	6.00	-	-	-	50.55
Ammoniated marl,	1	3.31	-	-	-	**1.61**	-	-	-	-	-	**10.39**	-	.41	9.98	-	-	-	-	-	-	-	-
Marl (North Carolina),	1	1.50	-	-	-	-	-	-	**.04**	-	-	**.56**	-	-	-	-	21.95	.61	-	-	-	-	50.18
Clay (so called),	1	.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	54.35	1.04	2.80	-	37.32	-	2.57
II. Guanos, Phosphates, etc.																							
Peruvian guano,	26	14.81	37.61	13.50	4.44	**7.85**	4.08	1.14	**2.61**	20.60	5.96	**15.26**	4.57	3.79	6.90	-	-	-	-	-	-	-	6.60
Bat guano from Texas,	9	40.09	18.24	10.51	2.58	**6.47**	-	-	**1.31**	6.53	1.00	**3.76**	-	-	-	-	-	-	-	-	-	-	2.00
Bat guano from Florida,	2	15.66	-	-	-	**9.74**	-	-	**1.77**	3.44	3.26	**3.35**	-	-	-	-	-	-	-	-	-	-	19.33
Rat guano from Florida,	1	10.32	-	-	-	**3.32**	-	-	**6.85**	-	-	**2.30**	-	-	-	-	-	-	-	-	-	-	1.15
Cuban guano,	5	24.27	-	2.74	.63	**1.67**	-	-	-	16.16	11.54	**13.35**	-	-	-	-	-	-	-	-	-	-	3.17
Caribbean guano (orchilla),	12	7.31	-	-	-	-	-	-	-	35.43	18.11	**26.77**	-	-	-	-	39.95	3.29	-	2.68	-	-	1.27
Mona Island guano,	1	13.32	-	-	-	**.76**	-	-	-	-	-	**21.88**	-	7.55	14.33	-	37.49	-	-	-	-	-	**2.45**

South Carolina rock phosphate,	7	1.36	-	-	-	-	-	-	-	30.51	24.70	27.42	.27	.07	27.13	-	41.87	3.03	4.80	-	-	-	9.04
South Carolina floats,	1	.83	-	-	-	-	-	-	-	-	-	23.39	-	2.33	21.06	-	-	-	-	-	-	-	20.16
Florida rock phosphate,	31	2.00	-	-	-	-	-	-	.21	38.97	6.95	26.02	-	1.47	19.70	-	30.40	-	7.68	-	2.08	-	27.29
Soft Florida phosphate,	3	4.87	-	-	-	-	-	-	-	19.94	17.71	18.73	-	-	-	-	23.72	-	6.82	-	-	-	20.92
Navassa phosphate,	2	7.60	-	-	-	-	-	-	-	34.45	34.09	34.27	-	-	-	-	37.45	-	10.27	-	-	-	2.70
Brockville phosphate,	1	2.50	-	-	-	-	-	-	-	-	-	35.21	-	-	-	-	-	-	-	-	-	-	6.46
Phosphatic slag,	4	1.45	-	-	-	-	-	-	-	30.51	18.91	23.49	-	3.06	21.65	-	48.66	3.42	10.12	-	-	-	9.40
Odorless phosphate,	6	2.99	-	-	-	-	.52	.04	.38	21.74	18.40	19.54	-	.52	19.82	-	51.42	-	-	-	2.51	-	9.14
Dissolved bone-black,	7	10.17	47.50	-	-	-	-	-	-	17.80	14.99	16.25	15.61	1.15	.37	-	-	-	-	-	-	-	3.99
Upton phosphate,	1	9.07	-	-	-	-	-	-	-	-	-	40.15	-	37.84	2.31	-	-	-	-	-	-	-	-
Bone-black,	5	4.60	-	-	-	-	-	-	-	30.54	16.56	28.28	-	-	-	-	-	-	-	-	-	-	3.64
Double superphosphate,	1	5.74	-	-	-	-	-	-	-	-	-	47.80	38.38	9.04	.38	-	16.00	-	-	1.19	-	-	.60
South American bone-ash,	1	7.00	-	-	-	-	-	-	-	-	-	35.89	-	-	-	-	44.89	-	-	-	-	-	4.50
Acid phosphate,	1	14.23	69.95	-	-	-	-	-	-	-	-	14.64	10.34	2.42	1.88	-	-	-	-	-	-	-	10.81
III. Refuse Substances.																							
Dried blood,	19	11.43	6.37	13.55	8.10	10.43	-	-	-	8.70	1.30	2.64	-	-	-	-	-	-	-	-	-	-	-
Ammonite,	1	5.88	-	-	-	11.33	-	-	-	-	-	3.43	-	-	-	-	-	-	-	-	-	-	1.38
Oleomargarine refuse,	1	8.54	14.42	-	-	12.12	-	-	-	-	-	.88	-	-	-	-	-	-	-	-	-	-	.96
Felt refuse,	1	29.24	33.53	-	-	5.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sponge refuse,	1	7.25	-	-	-	2.43	-	-	-	-	-	3.19	-	-	-	-	3.94	1.27	-	-	-	-	39.05
Blood and bone,	2	8.36	-	6.80	6.68	6.74	-	-	-	11.39	10.62	11.01	-	2.82	7.80	-	-	-	-	-	-	-	-
Horn shavings,	1	4.83	-	-	-	15.31	-	-	-	-	-	.42	-	-	-	-	-	-	-	-	-	-	-

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
III. Refuse Substances — Continued.																							
Ivory dust, ...	1	11.50	52.63	-	-	6.64	-	-	-	-	-	24.56	.97	17.97	5.62	-	-	-	-	-	-	-	-
Horn and hoof waste, ...	3	10.17	7.63	15.49	11.84	13.25	-	-	-	2.30	1.36	1.83	-	-	-	-	-	-	-	-	-	-	.24
Raw wool, ...	1	6.95	7.54	-	-	12.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.63
Wool waste, ...	11	11.77	24.10	10.20	.96	4.56	3.50	.06	1.68	.67	.05	.31	-	-	-	-	.11	.06	.80	-	-	-	8.20
Wool washings (water), ...	1	-	-	-	-	-	-	-	3.92	-	-	-	-	-	-	.49	.28	-	-	-	-	-	-
Wool washings (acid), ...	1	-	-	-	-	-	-	-	4.20	-	-	-	-	-	-	.40	.61	.20	-	-	-	-	-
Wool washings (alkaline), ...	1	92.03	3.28	-	-	.09	-	-	1.09	-	-	-	-	-	-	.92	.04	-	-	-	-	-	.22
Morocco factory waste, ...	1	22.72	-	-	-	1.16	-	-	.36	-	-	2.56	-	-	-	-	19.60	-	-	1.24	-	-	24.17
Meat scrap, ...	2	24.79	-	-	-	6.33	-	-	-	-	-	5.79	-	-	-	-	-	-	-	-	-	-	-
Meat mass, ...	5	12.09	13.60	11.50	9.69	10.44	-	-	-	3.58	.56	2.07	-	-	-	-	-	-	-	-	-	-	.58
Bone soup, ...	1	82.92	7.07	-	-	1.14	-	-	-	-	-	1.26	-	-	-	-	-	-	-	-	-	-	-
Dried soup from meat and bone, . .	1	14.80	8.40	-	-	9.97	-	-	-	-	-	.53	-	-	-	-	-	-	-	-	-	-	.64
Dried soup from rendering cattle feet, .	1	10.80	7.50	-	-	14.47	-	-	-	-	-	.46	-	-	-	-	-	-	-	-	-	-	.26
Dried soup from horse rendering, . .	1	92.14	-	-	-	1.12	-	-	-	-	-	.14	-	-	-	-	-	-	-	-	-	-	-
Soap-grease refuse, ...	2	29.25	51.39	4.20	2.21	3.21	-	-	-	15.37	11.04	13.21	-	-	-	-	-	-	-	-	-	-	1.29
Bones, ...	170	6.76	53.03	4.70	1.57	3.87	-	-	-	32.52	15.16	22.43	.38	8.62	13.77	-	-	-	-	-	-	-	1.08

Meat and bone,	2	5.26	-	-	-	4.57	-	-	-	-	-	20.21	.26	7.03	13.05	-	-	-	-	-	-	-	1.22
Tankage,	19	8.20	-	9.16	2.66	6.14	-	-	-	24.30	1.72	12.84	-	4.06	7.46	-	-	-	-	-	-	-	-
Fish with less than twenty per cent. water,	73	12.18	21.50	11.40	5.97	7.58	-	-	-	15.91	5.50	8.48	.55	2.64	5.06	-	-	-	-	-	-	-	2.01
Fish with between twenty and forty per cent. water.	10	30.19	20.59	7.41	4.22	5.97	-	-	-	8.32	4.68	7.09	.74	2.69	3.64	-	-	-	-	-	-	-	1.68
Fish with more than forty per cent. water,	10	45.46	15.50	7.60	2.43	4.97	-	-	-	8.56	2.94	5.08	1.17	1.33	2.58	-	-	-	-	-	-	-	1.35
Whale meat, raw,	1	44.50	1.04	-	-	4.86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lobster shells,	1	7.27	-	-	-	4.50	-	-	-	-	-	3.52	-	-	-	-	22.24	1.30	-	-	-	-	.27
Castor-bean pomace,	6	9.68	5.70	5.72	5.22	5.51	3.40	.64	1.57	2.26	1.57	2.18	-	-	-	-	.87	.29	-	-	-	-	1.75
Cotton-seed meal,	50	7.05	5.78	7.95	2.05	6.60	2.38	.48	1.76	3.36	.73	1.79	-	-	-	-	-	-	-	-	-	-	.28
Linseed meal,	2	8.43	-	-	-	6.34	-	-	1.25	-	-	1.84	-	-	-	-	-	-	-	-	-	-	-
Rotten brewers' grain,	1	78.77	-	-	-	.72	-	-	.04	-	-	.43	-	-	-	-	.26	.15	-	-	-	-	.59
Mill sweepings,	1	9.49	-	-	-	3.76	-	-	.66	-	-	1.18	-	-	-	-	-	-	-	-	-	-	5.01
Tobacco leaf,	1	13.05	21.01	-	-	2.75	-	-	7.24	-	-	.43	-	-	-	-	4.17	2.17	.32	-	-	-	4.17
Tobacco stems,	7	10.61	14.07	2.91	.90	2.30	10.60	3.76	7.03	2.09	.44	.62	-	-	-	.34	3.89	1.23	-	-	-	-	.82
Cotton waste, wet,	1	34.69	-	-	-	1.30	-	-	.80	-	-	1.54	-	-	-	-	2.45	1.13	-	-	-	-	41.33
Cotton waste, dry,	4	5.87	60.60	9.33	.96	1.77	1.76	.66	1.42	1.80	.26	.45	-	-	-	-	-	-	-	-	-	-	32.59
Refuse from calico works,	1	4.07	-	-	-	4.28	-	-	-	-	-	11.95	-	-	-	-	-	-	-	-	-	-	-
Cotton dust,	2	32.68	50.93	-	-	.78	-	-	.45	-	-	.32	-	-	-	-	-	-	-	-	-	-	42.22
Glucose refuse,	1	8.10	-	-	-	2.62	-	-	.15	-	-	.29	-	-	-	-	.18	.02	-	-	-	-	.07
Waste from lactate factory,	1	34.11	-	-	-	.68	-	-	-	-	-	.67	-	-	-	-	22.59	-	-	-	-	-	6.92
Hop refuse,	1	8.98	-	-	-	.98	-	-	.11	-	-	.20	-	-	-	-	.27	.10	-	-	-	-	.63
Banana skins,	1	13.99	-	-	-	.24	-	-	5.46	-	-	1.80	-	-	-	-	-	-	-	-	-	-	-

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
III. Refuse Substances — Concluded.																							
Tankage and blood,	1	14.43	-	-	-	5.88	-	-	-	-	-	6.84	5.44	1.08	.32	-	-	-	-	-	-	-	-
Sumac waste,	1	63.06	6.80	-	-	1.19	-	-	3.25	-	-	-	-	-	-	-	1.14	3.25	-	-	-	-	2.25
Eel grass,	2	35.39	15.60	.96	.70	.83	1.61	.21	.91	.41	.22	.32	-	-	-	1.63	2.13	.11	-	-	-	-	1.06
Pine-barren grass,	1	8.48	2.40	-	-	.16	-	-	.07	-	-	.18	-	-	-	-	-	-	-	-	-	-	1.67
Pine needles,	1	9.48	3.42	-	-	.46	-	-	.03	-	-	.12	-	-	-	-	-	-	-	-	-	-	1.22
Rockweed, green,	1	68.50	23.70	-	-	.62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rockweed, dry,	1	10.68	35.75	-	-	1.45	-	-	4.89	-	-	2.75	-	-	-	7.90	7.66	.21	-	-	-	-	10.40
Jute waste,	1	13.10	-	-	-	1.50	-	-	.08	-	-	.72	-	-	-	-	-	-	-	-	-	-	-
Hair waste,	1	72.81	-	-	-	1.39	-	-	.32	-	-	.61	-	-	-	-	-	-	-	-	-	-	-
Starch waste from rubber factory,	1	10.01	.23	-	-	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludge from sewage precipitating tanks,	1	88.49	9.50	-	-	.05	-	-	.05	-	-	.10	-	-	-	-	1.58	.39	6.22	-	-	-	.93
Sludge,	1	6.28	-	-	-	.68	-	-	-	-	-	1.36	-	-	-	-	8.66	-	17.68	-	-	-	38.03
Residue from water filter,	1	94.22	-	-	-	.12	-	-	-	-	-	.05	-	-	-	-	-	-	-	-	-	-	-
Blue-green algæ (*Lyngbia majuscula*), dry,	1	16.26	-	-	-	4.25	-	-	.79	-	-	.19	-	-	-	3.53	2.06	1.18	-	-	-	-	5.53
Mussel mud, wet,	1	60.01	27.29	-	-	.21	-	-	6.17	-	-	.10	-	-	-	.70	.93	.14	3.48	-	-	-	-
Mussel mud, dry,	1	2.24	72.02	-	-	.72	-	-	-	-	-	.35	-	-	-	-	23.39	-	8.26	-	-	-	37.60

Madder,	2	11.93	-	-	-	.91	-	-	2.40	-	-	.35	-	-	-	-	3.93	.51	-	-	-	-	4.67
Salt mud,	2	53.37	41.19	.40	.39	.40	.33	.32	.33	-	-	-	-	-	-	.94	.91	.37	4.13	-	-	-	34.88
Fresh-water mud,	1	40.37	-	-	-	1.37	-	-	.22	-	-	.26	-	-	-	-	1.27	.29	1.80	-	-	-	18.26
Muck,	25	61.69	13.75	2.54	.12	.79	-	-	-	.17	.08	.13	-	-	-	-	-	-	-	-	-	-	10.68
Peat, wet,	11	61.36	7.66	1.40	.41	.85	-	-	.18	-	-	.09	-	-	-	-	.55	.72	2.14	-	-	-	2.14
Peat, dry,	2	14.67	17.26	-	-	1.89	-	-	.06	-	-	.03	-	-	-	-	-	-	-	-	-	-	10.14
Turf,	2	19.29	6.36	1.97	1.91	1.94	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soot,	7	4.29	77.10	1.05	.09	.41	1.83	.21	.63	2.10	.19	1.13	-	-	-	-	2.99	1.19	6.38	-	-	-	66.06
IV. Animal Excrement, etc.																							
Barn-yard manure,	79	67.24	-	1.36	.21	.52	1.40	.13	.56	.75	.10	.39	-	-	-	-	.30	.19	-	-	-	-	8.00
Horse manure,	1	11.24	-	-	-	.74	-	-	2.82	-	-	1.46	-	-	-	-	-	-	-	-	-	-	12.60
Sheep manure,	4	29.22	-	-	-	1.44	-	-	1.17	-	-	.92	-	-	-	-	-	-	-	-	-	-	12.91
Drainage from a manure heap,	1	93.20	3.66	-	-	.98	-	-	.88	-	-	.24	-	-	-	-	-	-	-	-	-	-	-
Poudrette, dry,	1	5.25	35.45	-	-	3.58	-	-	.49	-	-	5.74	-	-	-	-	-	-	-	-	-	-	4.65
Goose manure,	1	48.92	-	-	-	.21	-	-	.81	-	-	.95	-	-	-	-	-	-	-	-	-	-	-
Hen manure, fresh,	2	52.35	24.75	1.20	.79	.99	.32	.18	.25	1.00	.47	.74	-	-	-	-	1.19	.89	-	1.24	-	-	23.50
Hen-house refuse,	2	7.37	-	-	-	.71	-	-	1.03	-	-	1.02	-	-	-	-	-	-	-	-	-	-	71.07

Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds.

	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
I. Chemicals, Refuse, Salts, Ashes, etc.													
Muriate of potash,	35.	-	-	1,020.	-	134.	-	11.	-	-	-	976.	14.
Sulphate of potash (high grade),	37.	-	-	804.	-	89.	-	30.	-	914.	-	-	15.
Sulphate of potash-magnesia,	96.	-	-	496.	-	125.	51.	-	-	885.	-	52.	28.
Carbonate of potash,	538.	-	-	370.	-	-	-	390.	-	-	-*	-	8.
Phosphate of potash,	75.	-	-	651.	750.	-	-	-	-	269.	-	-	18.
Kainite,	64.	-	-	271.	-	379.	23.	196.	-	405.	-	665.	43.
Carnallite,	-	-	-	274.	-	153.	-	264.	-	11.	-	831.	-
Krugite,	96.	-	-	168.	-	105.	249.	176.	-	639.	-	133.	299.
Sulphate of magnesia (kieserite),	454.	-	-	-	-	-	56.	346.	-	722.	-	-	115.
Nitrate of potash,	26.	-	254.	905.	-	-	-	-	-	-	-	-	-
Nitrate of soda,	28.	-	301.	-	-	710.	-	-	-	-	-	10.	10.
Sulphate of ammonia,	212.	-	441.	-	-	-	-	-	-	1,200.	-	-	-
Phosphate of ammonia,	120.	-	207.	-	877.	-	-	-	-	249.	-	-	16.
Sulphate of soda,	28.	-	-	-	-	-	-	-	-	1,189.	-	-	-
Saltpetre waste,	51.	-	44.	273.2	-	740.8	15.	38.	-	37.	-	925.	-

Nitre salt-cake,	121.	-	56.	17.	-	591.	-	-	-	955.	-	-	78.
Wood ashes,	208.	-	-	108.	30.	-	671.	66.	19.	-	-	-	326.
Cotton-seed-hull ashes,	172.	-	-	451.	172.	-	188.	209.	35.	-	-	-	269.
Ashes of spent tan-bark,	97.	-	-	36.	37.	-	622.	68.	36.	-	-	-	504.
Corn-cob ashes,	24.	-	-	142.	47.	-	234.	-	26.	-	-	-	1,042.
Railroad-tie ashes,	94.	-	-	18.	11.	-	50.	-	-	-	-	-	1,604.
Peat ashes,	93.	-	-	9.	2.	-	46.	33.	123.	-	-	-	903.
Logwood ashes,	30.	-	-	2.	56.	-	78.	-	-	-	-	-	194.
Hard-pine wood ashes,	15.	-	-	203.	45.	-	499.	-	-	-	-	-	598.
Mill ashes,	11.	-	-	32.	9.	-	699.	27.	-	-	-	-	727.
Ashes from cremation of swill,	97.	-	-	79.	283.	-	672.	27.	93.	-	-	-	431.
Ashes from blue works,	243.	1,276.	-	180.	-	-	-	-	-	-	-	-	246.
Seaweed ashes,	29.	-	-	18.	6.	175.	121.	87.	-	60.	-	132.	1,273.
Gypse,	33.	-	-	-	-	-	1,017.	-	-	-	-	-	57.
Nova Scotia plaster (gypsum),	179.	-	-	-	-	-	657.	15.	-	897.	-	-	69.
Onondaga plaster (New York gypsum),	265.	-	-	-	-	-	606.	93.	-	650.	164.	-	187.
Lime (burnt),	-	-	-	-	-	-	1,973.	-	-	-	-	-	27.
Waste lime,	16.	-	-	-	-	-	1,482.	-	-	-	-	-	8.
Gas-house lime,	446.	-	-	-	-	-	873.	166.	-	415.	-	-	121.
Lime waste from sugar factory,	726.	-	-	4.	45.	-	550.	-	-	-	-	-	6.
Lime-kiln ashes,	290.	-	-	26.	22.	-	851.	52.	-	-	355.	-	154.
Bituminous coal ashes,	73.	-	-	8.	9.	-	38.	-	-	-	-	-	1,483.

* Not determined.

Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds — Continued.

	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
I. Chemicals, Refuse, Salts, Ashes, etc. — Concluded.													
Carbonate of lime,	9.	-	-	-	-	-	1,060.	-	-	-	-	-	-
Marls (Massachusetts),	274.	-	-	5.	21.	-	810.	13.	14.	-	571.	-	69.
Marls (Virginia),	320.	-	-	10.	2.	-	145.	4.	-	13.	145.	-	1,285.
Green sand marls (Virginia),	25.	-	-	23.	187.	-	516.	-	103.	-	-	-	826.
Olive earth (Virginia),	39.	-	-	5.	275.	-	383.	-	120.	-	-	-	1,011.
Ammoniated marl,	66.	-	32.	-	208.	-	-	-	-	-	-	-	-
Marl (North Carolina),	30.	-	-	1.	11.	-	439.	12.	-	-	-	-	1,004.
II. Guanos, Phosphates, etc.													
Peruvian guano,	296.	752.	157.	52.	305.	-	-	-	-	-	-	-	132.
Bat guano from Texas,	802.	365.	129.	26.	75.	-	-	-	-	-	-	-	40.
Bat guano from Florida,	313.	-	195.	25.	67.	-	-	-	-	-	-	-	387.
Rat guano from Florida,	206.	-	66.	137.	46.	-	-	-	-	-	-	-	23.
Cuban guano,	485.	-	33.	-	267.	-	-	-	-	-	-	-	63.
Caribbean guano (orchilla),	146.	-	-	-	535.	-	799.	66.	-	54.	-	-	25.
Mona Island guano,	266.	-	15.	-	438.	-	750.	-	-	-	-	-	49.

South Carolina rock phosphate,	27.	-	-	-	549.	-	837.	61.	96.	-	-	-	181.
South Carolina floats,	17.	-	-	-	468.	-	-	-	-	-	-	-	403.
Florida rock phosphate,	40.	-	-	4.	520.	-	608.	-	154.	-	22.	-	546.
Soft Florida phosphate,	97.	-	-	-	375.	-	274.	-	136.	-	-	-	418.
Navassa phosphate,	152.	-	-	-	685.	-	749.	-	205.	-	-	-	54.
Brockville phosphate,	50.	-	-	-	704.	-	-	-	-	-	-	-	129.
Phosphatic slag,	29.	-	-	-	470.	-	973.	68.	202.	-	-	-	188.
Odorless phosphate,	60.	-	-	8.	391.	-	1,028.	-	-	-	50.	-	183.
Dissolved bone-black,	203.	950.	-	-	325.	-	-	-	-	-	-	-	80.
Upton phosphate,	181.	-	-	-	803.	-	-	-	-	-	-	-	-
Bone-black,	92.	-	-	-	565.	-	-	-	-	-	-	-	73.
Double superphosphate,	115.	-	-	-	956.	-	320.	-	-	24.	-	-	12.
South American bone ash,	140.	-	-	-	718.	-	898.	-	-	-	-	-	90.
Acid phosphate,	285.	1,399.	-	-	293.	-	-	-	-	-	-	-	216.
III. Refuse Substances.													
Dried blood,	229.	127.	209.	-	53.	-	-	-	-	-	-	-	-
Ammonite,	118.	-	227.	-	69.	-	-	-	-	-	-	-	28.
Oleomargarine refuse,	171.	288.	242.	-	18.	-	-	-	-	-	-	-	19.
Felt refuse,	585.	671.	105.	-	-	-	-	-	-	-	-	-	-
Sponge refuse,	145.	-	49.	-	64.	-	79.	25.	-	-	-	-	781.
Blood and bone,	167.	-	135.	-	220.	-	-	-	-	-	-	-	-
Horn shavings,	99.	-	306.	-	8.	-	-	-	-	-	-	-	-

Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds — Continued.

	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
III. Refuse Substances — Continued.													
Ivory dust,	230.	1,053.	133.	-	491.	-	-	-	-	-	-	-	-
Horn and hoof waste,	203.	153.	265.	-	37.	-	-	-	-	-	-	-	5.
Raw wool,	139.	151.	258.	-	-	-	-	-	-	-	-	-	72.
Wool waste,	235.	582.	91.	34.	6.	-	2.	1.	16.	-	-	-	164.
Wool washings (water),	-	-	-	78.	-	10.	6.	-	-	-	-	-	-
Wool washings (acid),	-	-	-	84.	-	8.	12.	4.	-	-	-	-	-
Wool washings (alkaline),	1,841.	66.	2.	22.	-	18.	1.	-	-	-	-	-	4.
Morocco factory waste,	454.	-	23.	7.	51.	-	392.	-	-	25.	-	-	483.
Meat scrap,	496.	-	127.	-	116.	-	-	-	-	-	-	-	-
Meat mass,	242.	272.	209.	-	41.	-	-	-	-	-	-	-	12.
Bone soup,	1,658.	141.	23.	-	25.	-	-	-	-	-	-	-	-
Dried soup from meat and bone,	296.	168.	199.	-	11.	-	-	-	-	-	-	-	13.
Dried soup from rendering cattle feet,	216.	150.	289.	-	9.	-	-	-	-	-	-	-	5.
Dried soup from horse rendering,	1,843.	-	22.	-	3.	-	-	-	-	-	-	-	-
Soap grease refuse,	585.	1,028.	64.	-	264.	-	-	-	-	-	-	-	26.

Ground bones,	135.	1,061.	77.	-	449.	-	-	-	-	-	-	-	22.
Meat and bone,	105.	-	91.	-	404.	-	-	-	-	-	-	-	24.
Tankage,	164.	-	123.	-	257.	-	-	-	-	-	-	-	-
Fish with less than twenty per cent. water,	244.	430.	152.	-	170.	-	-	-	-	-	-	-	40.
Fish with between twenty and forty per cent. water,	604.	412.	119.	-	142.	-	-	-	-	-	-	-	34.
Fish with more than forty per cent. water,	909.	310.	99.	-	102.	-	-	-	-	-	-	-	27.
Whale meat, raw,	890.	21.	96.	-	-	-	-	-	-	-	-	-	-
Lobster shells,	145.	-	90.	-	70.	-	445.	26.	-	-	-	-	5.
Castor-bean pomace,	194.	114.	110.	31.	44.	-	17.	6.	-	-	-	-	35.
Cotton-seed meal,	141.	116.	132.	35.	36.	-	-	-	-	-	-	-	6.
Linseed meal,	169.	-	127.	25.	37.	-	-	-	-	-	-	-	-
Rotten brewers' grain,	1,575.	-	15.	1.	17.	-	5.	3.	-	-	-	-	12.
Mill sweepings,	190.	-	75.	13.	24.	-	-	-	-	-	-	-	100.
Tobacco leaf,	261.	420.	55.	145.	9.	-	83.	43.	6.	-	-	-	83.
Tobacco stems,	212.	281.	46.	141.	12.	7.	78.	25.	-	-	-	-	16.
Cotton waste, wet,	694.	-	26.	16.	31.	-	49.	23.	-	-	-	-	827.
Cotton waste, dry,	117.	1,212.	35.	28.	9.	-	-	-	-	-	-	-	652.
Refuse from calico works,	81.	-	86.	-	239.	-	-	-	-	-	-	-	-
Cotton dust,	654.	1,019.	16.	9.	6.	-	-	-	-	-	-	-	844.
Glucose refuse,	162.	-	52.	3.	6.	-	4.	4.	-	-	-	-	1.
Waste from lactate factory,	682.	-	14.	-	13.	-	452.	-	-	-	-	-	138.
Hop refuse,	180.	-	20.	2.	4.	-	5.	2.	-	-	-	-	13.

Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds — Concluded.

	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
III. Refuse Substances — Concluded.													
Banana skins,	280.	-	5.	109.	36.	-	-	-	-	-	-	-	-
Tankage and blood,	289.	-	118.	-	137.	-	-	-	-	-	-	-	-
Sumac waste,	1,261.	136.	24.	65.	-	-	23.	65.	-	-	-	-	45.
Eel grass,	708.	312.	17.	18.	6.	33.	43.	2.	-	-	-	-	21.
Pine-barren grass,	170.	48.	3.	1.	4.	-	-	-	-	-	-	-	33.
Pine needles,	200.	68.	9.	1.	2.	-	-	-	-	-	-	-	24.
Rockweed, green,	1,370.	474.	12.	-	-	-	-	-	-	-	-	-	-
Rockweed, dry,	214.	715.	29.	98.	55.	158.	153.	4.	-	-	-	-	208.
Jute waste,	262.	-	3.	2.	14.	-	-	-	-	-	-	-	-
Hair waste,	1,456.	-	28.	6.	12.	-	-	-	-	-	-	-	-
Starch waste from rubber factory,	200.	5.	4.	-	-	-	-	-	-	-	-	-	-
Sludge from sewage precipitating tanks,	1,770.	190.	1.	1.	2.	-	32.	8.	124.	-	-	-	19.
Sludge,	126.	-	14.	-	27.	-	173.	-	354.	-	-	-	761.
Residue from water filter,	1,884.	-	2.	-	1.	-	-	-	-	-	-	-	-
Blue-green algæ (*Lyngbia majuscula*), dry,	325.	-	85.	16.	4.	71.	41.	24.	-	-	-	-	111.

Mussel mud, wet,	1,200.	546.	4.	123.	2.	14.	19.	3.	70.	-	-	-	-
Mussel mud, dry,	45.	1,440.	14.	-	7.	-	1,468.	165.	-	-	-	-	752.
Madder,	239.	-	18.	48.	7.	-	79.	10.	-	-	-	-	93.
Salt mud,	1,567.	824.	8.	7.	-	19.	18.	7.	83.	-	-	-	798.
Fresh-water mud,	807.	-	27.	4.	5.	-	25.	6.	36.	-	-	-	365.
Muck,	1,234.	275.	16.	-	3.	-	-	-	-	-	-	-	214.
Peat, wet,	1,227.	153.	17.	4.	2.	-	11.	14.	43.	-	-	-	43.
Peat, dry,	293.	345.	38.	1.	1.	-	-	-	-	-	-	-	203.
Turf,	386.	127.	39.	-	-	-	-	-	-	-	-	-	-
Soot,	86.	1,542.	8.	13.	23.	-	60.	24.	128.	-	-	-	1,321.
IV. Animal Excrement, etc.													
Barn-yard manure,	1,345.	-	10.	11.	8.	-	6.	4.	-	-	-	-	160.
Horse manure,	225.	-	15.	56.	29.	-	-	-	-	-	-	-	252.
Sheep manure,	584.	-	29.	23.	18.	-	-	-	-	-	-	-	258.
Drainage from manure heap,	1,864.	73.	20.	18.	5.	-	-	-	-	-	-	-	-
Poudrette, dry,	105.	709.	72.	10.	115.	-	-	-	-	-	-	-	93.
Goose manure,	978.	-	4.	16.	19.	-	-	-	-	-	-	-	-
Hen manure, fresh,	1,047.	49.	20.	5.	15.	-	24.	18.	-	25.	-	-	470.
Hen house refuse,	147.	-	14.	21.	20.	-	-	-	-	-	-	-	1,421.

5. Compilation of Analyses of Fruits, Garden Crops and Insecticides.

COMPILED BY H. D. HASKINS.

1. — Analyses of fruits.
2. — Analyses of garden crops.
3. — Relative proportions of phosphoric acid, potassium oxide and nitrogen in fruits and garden crops.
4. — Analyses of insecticides.

A computation of the results of a chemical analysis of twenty prominent garden crops shows the following average relative proportion of the three essential ingredients of plant food : —

	Parts.
Nitrogen,	2.2
Potassium oxide,	2.0
Phosphoric acid,	1.0

One thousand pounds of green garden vegetables contain, on the above-stated basis of relative proportion of essential constituents of plant food : —

	Pounds.
Nitrogen,	4.1
Potassium oxide,	3.9
Phosphoric acid,	1.9

The weight and particular stage of growth of the vegetables when harvested control, under otherwise corresponding conditions, the actual consumption of each of these articles of plant food. Our information regarding these points is still too fragmentary to enable a more detailed statement here beyond relative proportions. It must suffice for the present to call attention to the fact that a liberal manuring within reasonable limit pays, as a rule, better than a scanty one. — (C. A. Goessmann.)

1. *Analyses of Fruits.*

Fertilizing Constituents of Fruits.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Ericaceæ: —										
*Cranberries,	996	–	1.8	.9	.1	.3	.1	.3	–	–
*Cranberries,	894	.8	–	1.0	–	.2	.1	.3	–	–
Rosaceæ: —										
Apples,	831	.6	2.2	.8	.6	.1	.2	.3	.1	–
*Apples,	799	1.3	4.1	1.9	.3	.3	.3	.1	–	–
*Peaches,	884	–	3.4	2.5	–	.1	.2	.5	–	–
Pears,	831	.6	3.3	1.8	.3	.3	.2	.5	.2	–
Strawberries,	902	–	3.3	.7	.9	.5	–	.5	.1	.1
*Strawberries,	–	–	5.2	2.6	.2	.7	.4	1.0	–	–
*Strawberry vines,	–	–	33.4	3.5	4.5	12.2	1.3	4.8	–	–
Cherries,	825	–	3.9	2.0	.1	.3	.2	.6	.2	.1
Plums,	838	–	2.9	1.7	–	.3	.2	.4	.1	–
Saxifragaceæ: —										
*Currants, white,	–	–	5.9	3.1	.2	1.0	.3	1.1	–	–
*Currants, red,	871	–	4.1	1.9	.2	.8	.3	.9	–	–
Gooseberries,	903	–	3.3	1.3	.3	.4	.2	.7	–	–
Vitaceæ: —										
Grapes,	830	1.7	8.8	5.0	.1	1.0	.4	1.4	.5	.1
Grape seed,	110	19.0	22.7	6.9	.5	5.6	1.4	7.0	.8	.1

2. *Analyses of Garden Crops.*

Fertilizing Constituents of Garden Crops.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Chenopodiaceæ:—										
Mangolds,	880	1.8	9.1	4.8	1.5	.3	.4	.8	.3	.9
*Mangolds,	873	1.9	12.2	3.8	1.3	.6	.4	.9	–	–
Mangold leaves,	905	3.0	14.6	4.5	2.8	1.6	1.4	1.0	.8	2.3
Sugar beets,	805	1.6	7.1	3.8	.6	.4	.6	.9	.3	.3
*Sugar beets,	869	2.2	10.4	4.8	.8	.6	.4	1.0	.1	–
Sugar-beet tops,	840	2.0	9.6	2.8	2.3	.9	1.1	1.2	.2	.3
Sugar-beet leaves,	897	3.0	15.3	4.0	2.0	3.1	1.7	.7	.8	1.3
Sugar-beet seed,	146	–	45.3	11.1	4.2	10.2	7.3	7.5	2.0	1.9
*Red beets,	877	2.4	11.3	4.4	.9	.5	.3	.9	–	–
Spinach,	903	2.4	16.0	2.7	5.7	1.9	1.0	1.6	1.1	1.0
*Spinach,	922	3.4	9.6	9.6	2.1	.6	.5	.5	–	–
Compositeæ:—										
Lettuce, common,	940	–	8.1	3.7	.8	.5	.2	.7	.3	.4
Head lettuce,	943	2.2	10.3	3.9	.8	1.5	.6	1.0	.4	.8
*Head lettuce,	970	1.2	–	2.3	.2	.3	.1	.3	–	–
Roman lettuce,	925	2.0	9.8	2.5	3.5	1.2	.4	1.1	.4	.4
Artichoke,	811	–	10.1	2.4	.7	1.0	.4	3.9	.5	.2
*Artichoke, Jerusalem,	775	4.6	–	4.8	–	–	–	1.7	–	–
Convolvulaceæ:—										
Sweet potato,	758	2.4	7.4	3.7	.5	.7	.3	.8	.4	.9
Cruciferæ:—										
White turnips,	920	1.8	6.4	2.9	.6	.7	.2	.8	.7	.3
*White turnips,	895	1.8	10.1	3.9	.8	.9	.3	1.0	1.0	–
White turnip leaves,	898	3.0	11.9	2.8	1.1	3.9	.5	.9	1.1	1.2
*Ruta-bagas,	891	1.9	10.6	4.9	.7	.9	.3	1.2	–	–
Savoy cabbage,	871	5.3	14.0	3.9	1.4	3.0	.5	2.1	1.2	1.1
White cabbage,	900	3.0	9.6	4.3	.8	1.2	.4	1.1	1.3	.5
*White cabbage,	984	2.3	–	3.4	.3	.2	.1	.2	–	–
Cabbage leaves,	890	2.4	15.6	5.8	1.5	2.8	.6	1.4	2.4	1.3
Cauliflower,	904	4.0	8.0	3.6	.5	.5	.3	1.6	1.0	.3
Horse-radish,	767	4.3	19.7	7.7	.4	2.0	.4	2.0	4.9	.3

Fertilizing Constituents of Garden Crops — Continued.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Cruciferæ — Concluded.										
Radishes,	933	1.9	4.9	1.6	1.0	.7	.2	4.5	.3	.5
Kohlrabi,	850	4.8	12.3	4.3	.8	.4	.8	2.7	1.1	.6
Cucurbitaceæ: —										
Cucumbers,	956	1.6	5.8	2.4	.6	.4	.2	1.2	.4	.4
Pumpkins,	900	1.1	4.4	.9	.9	.3	.2	.7	.3	.4
Gramineæ: —										
Corn, whole plant, green,	829	1.9	10.4	3.7	.5	1.4	1.1	1.0	.3	.5
*Corn, whole plant, green,	786	4.1	–	3.8	.5	1.5	.9	1.5	–	–
Corn kernels,	144	16.0	12.4	3.7	.1	.3	1.9	5.7	.1	.2
*Corn kernels,	100	18.2	–	4.0	.3	.3	2.1	7.0	–	–
*Corn, whole ears,	90	14.1	–	4.7	.6	.2	1.8	5.7	–	–
*Corn stover,	282	11.2	37.4	13.2	7.9	5.2	2.6	3.0	–	–
Leguminosæ: —										
Hay of peas, cut green,	167	22.9	62.4	23.2	2.3	15.6	6.3	6.8	5.1	2.0
*Cow-pea (*Dolichos*), green,	788	2.9	–	3.1	.6	3.0	1.0	1.0	–	–
*Small pea (*Lathyrus sylvestris*), dry.	90	38.5	–	25.7	4.7	17.9	5.0	9.0	–	–
Peas (seed),	143	35.8	23.4	10.1	.2	1.1	1.9	8.4	.8	.4
Pea straw,	160	10.4	43.1	9.9	1.8	15.9	3.5	3.5	2.7	2.3
Garden beans (seed),	150	39.0	27.4	12.1	.4	1.5	2.1	9.7	1.1	.3
Bean straw,	166	–	40.2	12.8	3.2	11.1	2.5	3.9	1.7	3.1
Liliaceæ: —										
Asparagus,	933	3.2	5.0	1.2	.9	.6	.2	.9	.3	.3
Onions,	860	2.7	7.4	2.5	.2	1.6	.3	1.3	.4	.2
*Onions,	892	–	4.9	1.8	.1	.4	.2	.7	–	–
Solanaceæ: —										
Potatoes,	750	3.4	9.5	5.8	.3	.3	.5	1.6	.6	.3
*Potatoes,	798	2.1	9.9	2.9	.1	.1	.2	.7	–	–
Potato tops, nearly ripe,	770	4.9	19.7	4.3	.4	6.4	3.3	1.6	1.3	1.1
Potato tops, unripe,	825	6.3	16.5	4.4	.3	5.1	2.4	1.2	.8	.9
*Tomatoes,	940	1.7	–	3.6	–	.3	.2	.4	–	–
Tobacco leaves,	180	34.8	140.7	40.7	4.5	50.7	10.4	6.6	8.5	9.4
Tobacco stalks,	180	24.6	64.7	28.2	6.6	12.4	.5	9.2	2.2	2.4
*Tobacco stems,	106	22.9	140.7	64.6	3.4	38.9	12.3	6.0	–	–

Fertilizing Constituents of Garden Crops — Concluded.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Umbelliferæ: —										
Carrots,	850	2.2	8.2	3.0	1.7	.9	.4	1.1	.5	.4
*Carrots,	898	1.5	9.2	5.1	.6	.7	.2	.9	–	–
Carrot tops,	822	5.1	23.9	2.9	4.7	7.9	.8	1.0	1.8	2.4
Carrot tops, dry,	98	31.3	125.2	48.8	40.3	20.9	6.7	6.1	–	–
Parsnips,	793	5.4	10.0	.4	.2	1.1	.6	1.9	.5	.4
*Parsnips,	803	2.2	–	6.2	.1	.9	.5	1.9	–	–
Celery,	841	2.4	17.6	7.6	–	2.3	1.0	2.2	1.0	2.8

Most of the foregoing analyses were compiled from the tables of E. Wolff. Those marked * are from analyses made at the Massachusetts State Agricultural Experiment Station, Amherst, Mass.

3. *Relative Proportions of Phosphoric Acid, Potassium Oxide and Nitrogen in Fruits.*

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Ericaceæ: —			
*Cranberries,	1	3.0	–
*Cranberries,	1	3.4	2.6
Rosaceæ: —			
Apples,	1	2.7	2.0
*Apples,	1	1.9	1.3
*Peaches,	1	1.3	–
Pears,	1	3.6	1.2
Strawberries,	1	1.4	–
*Strawberries,	1	2.6	–
*Strawberry vines,	1	.7	–
Cherries,	1	3.3	–
Plums,	1	4.3	–
Saxifragaceæ: —			
*Currants, white,	1	2.8	–
*Currants, red,	1	2.1	–
Gooseberries,	1	1.9	–
Vitaceæ: —			
Grapes,	1	3.6	1.2
Grape seed,	1	1.0	2.7

Relative Proportions of Phosphoric Acid, Potassium Oxide and Nitrogen in Garden Crops.

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Chenopodiaceæ:—			
Mangolds,	1	6.0	2.3
*Mangolds,	1	4.2	2.1
Mangold leaves,	1	4.5	3.0
Sugar beets,	1	4.2	1.8
*Sugar beets,	1	4.8	2.2
Sugar-beet tops,	1	2.3	1.7
Sugar-beet leaves,	1	5.7	4.3
Sugar-beet seed,	1	1.5	–
*Red beets,	1	4.1	3.3
Spinach,	1	1.7	3.1
*Spinach,	1	19.2	6.8
Compositeæ:—			
Lettuce,	1	5.3	–
*Lettuce,	1	7.6	4.0
Head lettuce,	1	3.9	2.2
Roman lettuce,	1	2.3	1.8
*Jerusalem artichoke,	1	2.8	2.7
Convolvulaceæ:—			
Sweet potato,	1	4.6	3.0
Cruciferæ:—			
White turnips,	1	3.6	2.3
*White turnips,	1	3.9	1.8
White turnip leaves,	1	3.1	3.3
*Ruta-bagas,	1	4.1	1.6
Savoy cabbage,	1	1.9	2.5
White cabbage,	1	4.1	1.7
*White cabbage,	1	11.0	7.6
Cauliflower,	1	2.3	2.5
Horse-radish,	1	3.9	2.2
Radishes,	1	3.2	3.8
Kohlrabi,	1	1.6	1.8
Cucurbitaceæ:—			
Cucumbers,	1	2.0	1.3
Pumpkins,	1	.6	.7
Gramineæ:—			
Corn, whole plant, green,	1	3.7	1.9
*Corn, whole plant, green,	1	2.2	2.8
Corn kernels,	1	.6	2.8
*Corn kernels,	1	.6	2.6
*Corn, whole ears,	1	.8	2.5
*Corn stover,	1	4.4	3.7

Relative Proportions of Phosphoric Acid, Potassium Oxide and Nitrogen in Garden Crops — Concluded.

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Leguminosæ: —			
Hay of peas, cut green, . .	1	3.4	3.4
*Cow-pea (*Dolichos*), . . .	1	3.1	2.9
*Small pea (*Lathyrus sylvestris*),	1	3.4	4.2
Peas (seed), ...	1	1.2	4.3
Pea straw, ...	1	2.8	4.0
Garden beans (seed), . . .	1	1.2	4.0
Bean straw, ...	1	3.3	–
Liliaceæ: —			
Asparagus, ...	1	1.3	3.6
Onions, ...	1	1.9	2.1
*Onions, ...	1	2.6	–
Solanaceæ: —			
Potatoes, ...	1	3.6	2.1
*Potatoes, ...	1	4.1	3.0
Potato tops, nearly ripe, . .	1	2.7	3.1
Potato tops, unripe, . . .	1	3.7	5.3
*Tomatoes, ...	1	8.7	4.5
Tobacco leaves, ...	1	6.2	5.3
Tobacco stalks, ...	1	3.1	2.7
Tobacco stems, ...	1	10.7	3.8
Umbelliferæ: —			
Carrots, ...	1	2.7	2.0
*Carrots, ...	1	5.7	1.7
Carrot tops, ...	1	2.9	5.1
*Carrot tops, dry, ...	1	8.0	5.1
Parsnips, ...	1	3.8	2.8
*Parsnips, ...	1	3.3	1.2
Celery, ...	1	3.5	1.1

6. *Analyses of Insecticides.*

	Moisture.	Arsenious Oxide.	Copper Oxide.	Acetic Acid.	Nicotine.	Mercury.	Sulphur.	Sulphuric Acid.	Chlorine.	Calcium Oxide.	Potassium Oxide.	Ferric and Aluminic Oxides.	Matter Insoluble in Hydrochloric Acid.
Average of 12 analyses, ordinary Paris Green,	1.22	57.91	32.08	4.74	-	-	-	-	-	-	-	-	.20
Average of 4 analyses, "Lion Brand New-process Paris Green,"	4.64	54.91	7.93	-	-	-	-	6.65	-	15.76	.35	-	1.00
"Sulphatine,"	1.40	-	2.61	-	-	-	48.28	4.73	-	18.60	-	-	1.63
"Death to Rose Bugs,"	2.95	-	1.05	-	-	-	34.53	4.35	-	17.76	-	-	.49
"Professor De Graff's Carpet Bug Destroyer,"	95.81	-	-	-	-	.78	-	.48	.27	-	.26	.90	-
"Oriental Fertilizer and Bug Destroyer,"	87.14	2.38	-	-	-	-	-	.64	3.00	-	3.50	-	-
"Non-poisonous Potato Bug Destroyer,"	-	-	-	-	-	-	-	-	-	68.20	-	1.38	1.50
Tobacco liquor,	37.71	-	-	-	2.12	-	-	-	-	3.07	6.55	.23	-
Tobacco liquor,	40.89	-	-	-	.53	-	-	-	-	1.47	16.34	.01	-
Tobacco liquor,	-	-	-	-	4.55	-	-	-	-	-	-	-	-
Tobacco liquor,	-	-	-	-	4.82	-	-	-	-	-	-	-	-
"Nicotinia,"	10.00	-	-	-	-	-	-	-	-	4.45	9.15	-	2.12
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	2.34
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	38.12
"Peroxide of Silicate,"	1.65	.57	.33	-	-	-	-	49.66	-	41.18	-	-	2.31

As a rule, in all preceding analyses the essential constituents are determined and stated; blanks do not imply the absence of the non-essentials.

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